# NAVAL POSTGRADUATE SCHOOL

**MONTEREY, CALIFORNIA**

# THESIS

**REDEFINING THE AUSTRALIAN ARMY OFFICER CORPS ALLOCATION PROCESS**

by

David G. Nelson

March 2010

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| Thesis Co-Advisors: | William Gates<br>William Hatch |

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Optimization models were developed that maximized cadet preferences whilst also meeting service requirements. Data from cadets who graduated from the Royal Military College in 2008 and 2009 was utilized to assess four different optimization models. The models that were developed showed significant increases in those cadets who received their first or second preference and significant decreases in cadets being allocated to the third, fourth or other preferences.


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# REDEFINING THE AUSTRALIAN ARMY OFFICER CORPS ALLOCATION PROCESS

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# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ACOL | Annualized Cost of Leaving Model |
| ADFA | Australian Defense Force Academy |
| CAB | Corps Allocation Board |
| CNA | Centre for Naval Analysis |
| DOCM-A | Directorate of Officer Career Management - Army |
| DoD | Department of Defense |
| DPERS-A | Directorate of Personnel - Army |
| DRM | Dynamic Retention Model |
| ECP | Enlisted Commissioning Program |
| MCP | Meritorious Commissioning Program |
| MECEP | Marine Corps Enlisted Commissioning Program |
| MOS | Military Occupational Specialties |
| MSO | Minimum Service Obligation |
| NPS | Naval Postgraduate School |
| NROTC | Naval Reserve Officer Training Course |
| OCC | Officer Candidate Course |
| OCS | Officer Cadet School |
| PLC | Platoon Leaders Course |
| RMC | Royal Military College |
| USMC | United States Marine Corps |
| USNA | United States Naval Academy |
| TBS | The Basic School |
| TFDW | Total Force Data Warehouse |

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# EXECUTIVE SUMMARY


The purpose of this research is to determine whether Corps allocation is a significant factor affecting the retention of Australian Army officers. Ascertaining whether there is any correlation between Corps allocation and retention required capturing a large amount of data. Unfortunately, this data was not available for Australian officers, so the United States Marine Corps Military Occupational Specialties (MOS) process was analyzed. The Marine Corps MOS allocation process is similar to the Australian Army's corps allocation process, which allows comparisons to be drawn.

The Marine Corps data was refined to allow for regression analysis to be conducted. The regression model that was developed was a simple linear probability model (a multiple linear regression model with a binary dependant variable). The results from the regression showed that remaining in the military beyond your minimum service obligation was positively affected by receiving your first MOS preference, having prior service, being a male, being married and having a master's degree. Remaining in the military beyond the minimum service obligation was negatively affected by the following factors: receiving an MOS outside your top three preferences, being Hispanic, and having a higher number of dependents.

As corps allocation affects officer retention, it is essential to optimize the preferences of each cadet during the allocation process. Models were developed that maximized cadet preference, subject to meeting service requirements. Data from cadets who graduated from the Royal Military College in 2008 and 2009 was utilized to develop more robust and effective allocation models. The models that were developed showed significant retention increases in those cadets who received first or second preference and significant retention decreases in cadets allocated to their third, fourth or other preference.

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# I. INTRODUCTION

## A. BACKGROUND

Toward the end of training at the Royal Military College (RMC), all cadets are allocated to a specific corps.[1] The vast majority of cadets will serve their entire military career within this corps. The allocation of cadets is a crucial element that shapes and defines the careers of Australian Army Officers.

From the time of enlistment to graduation from RMC, cadets spend between 18 and 48 months in training.[2] This significant investment in training is designed to prepare cadets for careers in the Army by promoting leadership and integrity. It also inculcates a sense of duty, loyalty, and service to the nation. Prior to graduating from RMC, each cadet selects four corps they would like join. RMC staff then attempt to match up the positions that are available with the cadets' preferences. The hypothesis of this paper is that cadets who receive lower order preferences have a significantly different retention profile than those cadets who receive their first or second preferences.

## B. PURPOSE

The purpose of this research is to determine whether corps allocation is a significant factor affecting the retention of Australian Army officers. This thesis will address the following primary question:

1. Does a cadet's allocation to either their first, second, third, or fourth corps preference affect their propensity to discharge?

This thesis will also address the following secondary question:

2. What are the alternatives to the current corps allocation process in the Australian Army?

---

[1] A separate branch or department of the Army that has a specialized function.

[2] Australian Defence Force Academy cadets will have trained for at least 48 months and Royal Military College direct entry cadets will have trained for at least 18 months.

## C. CONTEXT

The military is like any organization, in that employee retention and employee turnover are critical elements of manpower planning. Officer retention is particularly important, because of the monetary investment in the training and education given to junior officers. The very nature of the Australian Army recruiting system reinforces the importance of officer retention as there is virtually no lateral entry. According to Jaquette and Nelson (1974), this type of recruiting system is defined as a closed system. To ensure sufficient numbers of senior officers, the Army must ensure it recruits, promotes, retains, and discharges an appropriate number of personnel.

The defining moment in the career of a young cadet is when they receive their corps allocation. Many of the men and women who voluntarily chose to enter the military have a specific corps within which they desire to serve, and not being allocated to this corps can be a shattering experience. Failing to secure a high preference could have a lasting impact upon their future military career.

## D. DATA

The Australian Army does not maintain suitable data on officer retention that can be matched to corps preference and Corps allocation. The United States Marine Corps (USMC) does maintain this data; this thesis will analyze this data to assess the presence of a relationship between corps allocation and retention, as such. The USMC training dynamic and corps allocation process are extremely similar to those of the Australian Army. It is possible to relate the conclusions that are drawn about the USMC to the Australian Army, because of the similarities between the two countries and their armed forces.

Like the Australian military, the United States military is drawn entirely from volunteers. Both militaries also invest heavily in officer training and have compulsory minimum periods of service that follow commissioning. Australia and the United States also share the same language, similar political systems, and comparable cultural beliefs.

If USMC retention is affected by whether or not individuals receive their first, second, third, or fourth preference, then one can assume parallel results for Australian Army officers.

## E. SCOPE AND METHODOLOGY

This research will analyze the relationship between officer corps allocation and propensity to discharge. It will also evaluate the Australian Army officer corps allocation process and determine whether a more effective system is available to maximize officer preferences whilst still meeting service manning requirements.

The first segment will be a literary review of the trends related to officer corps allocation. It will examine what methods other developed countries are using to assign junior officers to a trade.

The second segment will analyze of the effects of corps allocation on an officer's propensity to discharge. United States data will be utilized to ascertain whether cadets who obtain lower corps preferences are more or less likely to discharge.

The third segment will review the current Australian corps allocation process. It will evaluate alternate methods for maximizing cadet preferences whilst also meeting service requirements. Data from cadets who graduated from RMC in 2008 and 2009 will be utilized to develop more robust and effective allocation models.

The summary, conclusions, and recommendations will link the findings from the United States and Australian data, and will offer possible alternatives to the current process of corps allocation in the Australian Army. The end result is to show whether a more effective allocation process can help boost retention of Australian Army officers.

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# II. LITERATURE REVIEW

## A. OVERVIEW

Few topics within human resource management have captured as much attention as employee turnover. Since the mid 1900s, there has been an enormous amount of both qualitative and quantitative research done to ascertain why an organization either retains or loses its employees. It was more than 50 years ago that the groundbreaking research of March and Simon (1958) proposed that employees confront two fundamental decisions when dealing with employers. One is the decision of whether to produce and the other is the decision of whether to participate. The focus of this literature review will be on the latter: the factors that affect an individual's decision to participate for an organization. The reason why March and Simon (1958) and numerous other researchers have done so much work on this topic is twofold. First, the factors that affect and define turnover rates are diverse and varied and, second, excessive turnover can have a catastrophic impact on an organization.

The study of the mind and the mental processes that an individual undertakes, especially in relation to behavior, is termed "psychology." Psychology seeks to understand and explain phenomena such as perception, attention, emotion, behavior, personality, and motivation. There are numerous factors that affect an individual's psychology, and there also numerous fields of psychology. Some of the more prominent fields of psychology include: child psychology, cognitive psychology, and social psychology. This research deals predominantly with aspects within either the cognitive or social psychology areas. Cognitive psychology deals with how the human mind receives and interprets impressions and ideas. Social psychology looks at how the actions of others influence the behavior of an individual. This literature review will draw upon many different authors in an attempt to compile a list of the key factors that influence the psychology of an individual's retention decisions.

All organizations rely upon a certain number of employees entering and leaving to increase effectiveness. The inflow of new personnel brings with it new ideas and new philosophies. However, the challenge for manpower planners is to ensure this employee turnover is optimized as the costs of high turnover are significant. In relation to military officers, the financial cost of recruiting and training suitable replacements is extremely high. In a closed system, such as the military, any officer that discharges has to be replaced by another from within the organization. The military must retain enough officers at the junior and mid-level ranks for the organization to function effectively. In the context of this study, retention will be defined as an officer's voluntary decision to remain on active service, beyond their initial return of service obligation. The higher the retention levels, the more the military is able to recoup its training investment. It is therefore paramount that the military is acutely aware of the factors that affect the retention dynamics of its officers. This chapter will examine the major findings of both civilian and military research into employee turnover.

Researchers studying employee turnover have utilized approaches that have been largely defined by the disciplinary matrix or methodology they have adopted. These studies can be divided into two broad groups. The first group attempts to provide general models and the second studies specific variables. March and Simon (1958) were among the first to attempt to combine both methodologies into one model. They built a generalized model of turnover, but incorporated dependant criteria within the model. These criteria are grouped as:

a. personal characteristics: age, sex, marital status, and length of service.

b. organizational characteristics: size of work group, visibility of organization, reputation of the organization, and the number of extra-organizational alternatives.

c. job-related characteristics: rewards, supervision, job satisfaction, pay, and promotion prospects.

March and Simon (1958) argued that the inter-relationship among these variables will determine the turnover phenomenon.

After March and Simon (1958) there was a period from 1960 through the early 1970s when economists dominated the debate about workforce turnover. The patterns of employee retention were linked exclusively to pay and labor market factors. It was not until the mid 1970s that psychologists such as Mobley (1977) once again placed the spotlight on job satisfaction, promotion prospects, and work environment. There was further refinement in 1979 by Mobley, Griffeth, Hand, and Meglino in their article entitled, "Review and Conceptual Analysis of the Employee Turnover Process." Their article was successful in truly applying a multivariate approach to worker turnover. Instead of adopting a singular focus, the authors endeavored to capture all of the significant elements that can impact an individual's decision to either stay or leave.

The dynamic between employer and employee has changed significantly over the past two decades. As Sims (1994) points out, there is no longer the cradle-to-grave relationship that once dominated the employment landscape. Previously, employers were expected to look out for and protect employee's interests and, in turn, employees were expected to protect employer interests. There was a clear expectation that the employee / employer relationship would be a long-term, stable, and predictable relationship where a set amount of work would yield a specific level of rewards. This dynamic was especially strong in the military, where there were very attractive pension packages available for personnel who served for greater than 20 years. Rousseau and Geller (1994) state that the new psychological contract between employer and employee is characterized by fluidity and brevity. Employees are now far more likely to move from one job to the next and from one career to the next. The challenge for employers is to create a sense of belonging and commitment to the organization that will bond the employee to the company.

Like March and Simon (1958), the majority of academics believe that the factors that shape retention patterns can be grouped into two categories. These two categories are work-related factors and individual characteristics.

## B. WORK-RELATED FACTORS

Numerous studies have analyzed the internal and external work related factors that correlate with individuals either leaving or remaining with an organization. These

studies have found that factors, such as job satisfaction, economic conditions, and pay have an important impact on employee turnover.

Job satisfaction is the extent to which individuals derive pleasure or enjoyment from their jobs. Job satisfaction is among the most popular and widely debated topics in the area of organizational behavior and human resource management. The reasons for this interest are quite varied and include the idea that understanding the potential sources of job satisfaction will help develop organizational models that maximize employee motivation, performance, and retention. A higher level of employee satisfaction relates to a lower level of employee turnover. Authors such Porter and Steers (1973), Pearson (1995) and Mowbay (1977) have proven that the link between job satisfaction and employee turnover is significant and consistent, and it is generally quite strong.

A factor that parallels turnover rates is the condition of the economy: in particular, the unemployment rate. The unemployment rate is important because there is strong evidence to indicate that people link the unemployment rate with perceived job opportunities. An individual's probability of finding alternate work has been shown by Mobley, Horner, and Hollingsworth (1978) to have a significant and positive effect on turnover rates. A lower unemployment rate (high probability of finding alternate employment) leads to a higher turnover rate (more people who transfer between organizations).

The level of pay or remuneration individuals receive also impacts whether they will remain with an organization or seek alternate employment. Mobley, Griffeth, Hand, and Meglino (1979) claimed that an individual's pay satisfaction was significantly correlated to turnover rates. Cotton and Tuttle (1986) conducted a review of 32 turnover studies, and they found significant evidence to support the hypothesis of a negative relationship between pay and turnover rates. Within the studies that they examined, 29 of 32 data sets found that higher pay led to lower employee turnover.

## C. INDIVIDUAL CHARACTERISTICS

Numerous studies have focused on the individual or personal factors that shape workforce turnover. These variables include factors such as: age, gender, marital status, length of tenure, and educational status. Each of these individual factors has varying degrees of influence on whether a person chooses to leave an organization or stay employed with the organization.

The degree to which an individual's expectations are being met also correlates to employee turnover. Porter and Steers (1973) identified that employees who enter an organization with realistic expectations that the organization can meet are less likely to leave than those employees whose expectations are not being met. The reason for this is that employees whose expectations are being met are essentially being rewarded with the experience and job for which they signed up. The employee believes the employer is upholding their end of the unwritten contract into which the two parties entered. This concept is crucially important in the context of military officers, because many young men and women join the Army with very specific expectations for their careers. They may have family connections or other interests that have led them to want to join a particular Corps. Assigning these cadets to a Corps that is not their first choice means that their expectations are not being met. Muchinsky and Tuttle (1979) and, more recently, Pearson (1995) argue that failing to meet employees' expectations will result in a far higher turnover rate.

Age is an important factor when assessing whether an individual will stay with an organization. Older employees are less likely to resign than their younger colleagues because many may find it more difficult to secure alternate employment. Employers still discriminate both intentionally and unintentionally with their recruitment and selection practices. Porter and Steers (1973) identified a strong positive relationship between age and retention. This was further supported by a study conducted by Mobley, Griffeth, Hand, and Meglino (1979), who confirmed that an employee's propensity to resign declined as they got older. Cotton and Tuttle (1986) found that a majority of the studies

that they examined supported the negative relationship between age and turnover; in other words the older employees are the less likely they are to resign.

Educational status has consistently been linked to employee turnover. It is believed that individuals with more education are more likely to leave an organization. The rationale is that an individual with increased education has greater employment opportunities than a less-qualified counterpart. Cotton and Tuttle (1986) summarized that nearly all of the 32 studies they examined had a positive relationship between education and turnover.

There are numerous studies that examine the relationship between employee turnover and marital status; the problem is that the findings are very mixed. Some authors, such as Arnold and Feldman (1982), have concluded that married employees are far less likely to transition between jobs than their unmarried counterparts. In direct contrast 6 of the 32 studies that were reviewed by Cotton and Tuttle (1986) showed that married individuals were more likely to turn over than those who were not married. There are some authors who believe the results are so varied because the married / unmarried variable is too broad. Porter and Steers (1973) propose that the single demographic variable of marital status be further refined into family size and composition.

In their early studies of retention, Porter and Steers (1973) discovered that increased tenure had a positive impact upon an individual's propensity to remain with a particular employer. This was further supported when Mobley, Griffeth, Hand and Meglino (1979) conducted a study that confirmed tenure was consistently and positively related to retention. The longer an individual works for an organization, the stronger is their bond and affinity with the organization, and therefore the less likely the individual is to transfer to another company.

Varying measures of personality traits, coupled with interest inventories, have proven to be quite effective in predicting turnover rates within the civilian community. The key personality traits that authors such as Cotton and Tuttle (1986) generally believe correlates with employee turnover include: stress management / coping skills, desire for recognition, need for achievement, and locus of control. The vast majority of authors who

researched the link between personality traits and turnover rates concluded that these traits were very good predictors. The problem is that personality traits are very occupation specific: the relative significance of a particular personality trait can not be transferred across occupational groups.

Studies linking measures of intelligence or aptitude with organizational turnover have been inconclusive. The findings have been split evenly: some studies have stated there is no relationship, while others have said there is a positive relationship, and yet others have concluded there is a negative relationship. Muchinsky and Tuttle (1979) analyzed numerous personality studies and concluded that no clear pattern or correlation was evident between intelligence / aptitude and employee turnover.

A summary of the civilian literature effects and strengths for each variable is shown in Table 1. The table reflects the majority consensus assessment for each variable that was detailed in the civilian literature.

Table 1. Variable Effect and Variable Strength

| **VARIABLE** | **DIRECTION OF EFFECT** | **STRENGTH OF EFFECT** |
|---|---|---|
| Job satisfaction | Negative | Strong |
| Economic condition | Negative | Mild / Strong |
| Pay | Negative | Mild / Strong |
| Met expectations | Negative | Mild |
| Age | Negative | Mild |
| Education | Positive | Mild |
| Marital status | Mixed | Weak |
| Tenure | Negative | Mild |

| VARIABLE | DIRECTION OF EFFECT | STRENGTH OF EFFECT |
|---|---|---|
| Personality traits | Mixed | Weak |
| Intelligence | Mixed | Weak |

## D. MILITARY SPECIFIC

The dynamics of a career within the military are quite different from a job within the civilian environment. The nature of the work that military members perform, and the contracts under which they enlist, result in a unique turnover paradigm. The studies that have been conducted with a military focus have concentrated on many of the same factors as the civilian studies. For the most part, the results from military studies have been fairly similar to the results obtained from civilian studies. The difference between the two has been the significance and direction that the variables have on turnover rates. Some variables that have a positive effect in the civilian context are found to have a negative impact within the military. Conversely, some variables that have a negative effect in the civilian context are found to have a positive impact within the military.

Wilcove, Burch, Conroy, and Bruce (1991) conducted an extremely comprehensive comparison of both military and civilian turnover research (Table 2). They concluded that while similar turnover variables have been examined in the military and the civilian community, there are differences in the extent to which the variables have been examined. The military tends to focus on the family dynamic issues such as separation lengths and deployment history. The civilian studies have focused on work and personal factors.

Table 2. Summary of Military Turnover Variables (From Burch, Conroy, & Bruce, 1991)

| **VARIABLE** | **DIRECTION OF EFFECT** | **STRENGTH OF EFFECT** |
|---|---|---|
| Age | Negative | Mild |
| Marital Status | Positive | Mild |
| Race | Mixed | Weak |
| Education | Negative | Mild |
| Personality | Negative | Weak |
| Aptitude | Mixed | Weak |
| Job challenge / job satisfaction | Negative | Strong |

The Wilcove, Burch, Conroy, and Bruce (1991) research concluded that job challenge / job satisfaction was strongly and consistently associated with turnover rates. The greater the challenge and reward that individuals receive from their work, the lower the organization turnover. The authors also noted that recent studies have placed an increasingly greater emphasis on job factors in comparison to early studies.

The importance of job satisfaction as a turnover influence was further supported by Vernez and Zellman (1987), when they analyzed the 1979 United States Department of Defense Survey of Personnel. The study showed that job-related reasons were rated either the first or second most important factors affecting members who were considering discharging. The authors stated that these results applied to both officers and enlisted members. Vernez and Zellman (1987) were convinced that within the military there was a very profound link between job factors and discharge intentions. This conclusion was later supported by Lakhani (1991) when he conducted a cost / benefit analysis of united States officer retention.

Measures of intelligence or aptitude have been studied quite extensively in the civilian community, but they have received very limited attention within the military environment. The studies that have been conducted on military personal have focused mainly on enlisted members. A study by Githens, Neumann, and Abrahams (1966) found no correlation between the length of service of United States Naval officers and their scores on the Naval College Aptitude test or the Officer Classification Battery scores.

A unique variable within the military turnover dynamic is the issue of mental strength or mental toughness. Employment within the military is physically and mentally more demanding than most civilian jobs. According to authors such as Cigrang, Todd, Fielder, and Carbone (1999), psychological stamina needs to be considered when analyzing turnover rates. These authors stress the importance of mental health during the initial periods of training. The transition from civilian to military culture can be accomplished only through intense training programs that place new recruits in demanding situations that exceed their previous mental and physical limits.

A key concept in the analysis of military turnover is the Annualized Cost of Leaving Model (ACOL). Warner and Goldberg developed this model in 1984 to predict the effect of pay on separation rates. The model compares an individual's cost of leaving the military to the expected utility or reward they will derive from civilian employment. The model has been used extensively by the Department of Defense to evaluate alternate compensation strategies and their effect on employee turnover rates.

When the ACOL model was first developed, it was mainly used to assess enlisted personnel. Smoker (1984) refined the ACOL model to estimate the effects on both officers and enlisted personnel. The results that he obtained showed that the estimated ACOL coefficient is closely linked to the assumed discount rate. The next step in theoretical modeling was taken by Gotz and McCall (1984) when they developed the Dynamic Retention Model (DRM). The DRM extends the Warner and Goldberg (1984) model to officers' career decisions. The DRM adds two additional elements to the ACOL model: future uncertainty and taste for service. The DRM also considers the value an

officer may place on future career flexibility. The DRM can be used to explore different policy options by taking individual retention decisions and running them through various policy alternatives.

## E. LITERATURE SUMMARY

The research literature clearly suggests that numerous factors help to predict employee turnover, both military and civilian. The factors most commonly cited in the literature include job satisfaction, pay, individual personal characteristics, promotion opportunities, unemployment rate, and met expectations. The most consistent relationship that emerged from both civilian and military research is that turnover is inversely associated with job autonomy and job satisfaction. The more individuals feel empowered and autonomous in their jobs, the higher their levels of job satisfaction and the higher their propensity to remain with the organization. The literature provides a very good indication of what variables should be included in a model that endeavors to quantify the factors correlated with employee turnover.

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# III. REGRESSION ANALYSIS OF UNITED STATES MARINE CORPS OFFICERS

## A. PURPOSE

The purpose of this chapter is to detail the United States Marine Corps (USMC) officer commissioning system and to ascertain whether there is any correlation between corps accession source allocation and retention. Firstly, the chapter will cover each of the seven different accession sources to highlight the significant investment involved in training USMC officers. Secondly, this chapter will develop regression models that quantify the positive or negative impacts that USMC allocation has on retention.

## B. COMMISSIONING PROGRAMS

There are seven different avenues through which a USMC officer can enlist; each of these accession avenues is unique in terms of the potential candidate pool, the entry requirements, and the length of training. The seven different commissioning sources are as follows:

### 1. The United States Naval Academy (USNA)

Cadets who enter the USNA undertake a four-year training program that involves both academic and military training. They graduate as an officer in either the Navy or the USMC. To be eligible for consideration to attend the USNA, applicants must be United States citizens, unmarried, have no dependants, be medically fit, and be at least 17, but no older than 23, years of age. All USNA graduates are required to serve a minimum of five years of active service.

### 2. Naval Reserve Officer Training Course (NROTC)

The NROTC is the second officer accession program that the Marine Corps runs in conjunction with the Navy. The NROTC provides scholarship and non-scholarship

options at selected universities and colleges throughout the United States. In addition to their academic training, NROTC midshipmen also receive extensive military training. To be eligible for consideration, the NROTC applicants must be United States citizens, medically fit, at least 17, but no older than 23 years, of age, and have no criminal record. The minimum return of service obligation varies but is generally four years' active service.

### 3. Platoon Leaders Course (PLC)

The PLC program is open to all college students who are attending accredited colleges and universities as full-time students. The program enables students to continue with their studies, whilst also attending the Officer Candidate School (OCS). The training at OCS consists of two six-week courses that are held during the summer holidays. The minimum return of service obligation varies but is generally three years' active and five years' reserve service.

### 4. Officer Candidate Course (OCC)

The OCC is a commissioning program that is open to college seniors or graduates. It provides prospective USMC officers with a glimpse of Marine Corps life with absolutely no commitment. Entry into the OCC begins with a ten-week course at OCS. If candidates pass this ten-week course, they can choose to receive a reserve commission and go to The Basic School (TBS) for additional training. The minimum return of service obligation is generally three years' active service and five years' reserve service.

### 5. Marine Corps Enlisted Commissioning Program (MECEP)

The MECEP is designed to provide enlisted active duty Marines with the opportunity to earn a college degree and become a USMC officer. Applicants must have a minimum of six years' active service and have attained the rank of Corporal or above. If accepted into the program, the applicant attends a college with an NROTC unit on campus. The minimum return of service obligation is four years' active service.

### 6. Enlisted Commissioning Program (ECP)

The ECP allows qualified Marines to apply for assignment to Officer Cadet School (OCS). To be eligible to apply for the program, Marines must have at least a bachelor's degree and be between 21 and 30 years of age. Upon graduation from OCS, officers must serve a minimum of four years of active service and four years' reserve service.

### 7. Meritorious Commissioning Program (MCP)

The MCP ensures that Marines who do not have a bachelor's-level degree still have an avenue for commissioning as a USMC officer. This program gives Commanding Officers the ability to nominate highly qualified enlisted Marines who have displayed exceptional leadership. If accepted into the program, Marines attend the 10-week course at OCS. The minimum return of service obligation is four years of active service and four years' reserve service.

One common element of these seven different avenues is the minimum service obligation (MSO). The MSO defines how long a USMC officer is obligated to serve before becoming eligible to discharge. A summary of each commissioning source's MSO is contained in Table 3.

Table 3. Summary of Active Service MSO

| Commissioning Source | Active Service MSO |
|---|---|
| 1. The United States Naval Academy (USNA) | 5 years |
| 2. Naval Reserve Officer Training Course (NROTC) | 4 years |
| 3. Platoon Leaders Course (PLC) | 3 years |
| 4. Officer Candidate Course (OCC) | 3 years |
| 5. Marine Corps Enlisted Commissioning Program (MECEP) | 4 years |

| Commissioning Source | Active Service MSO |
|---|---|
| 6. Enlisted Commissioning Program (ECP) | 4 years |
| 7. Meritorious Commissioning Program (MCP) | 4 years |

## C. COMMON MARINE CORPS OFFICER TRAINING

After earning a commission via one of the seven accession sources, all USMC officers attend six months of training at TBS. During their six-month course at TBS, lieutenants receive training that is designed to give them the skills and knowledge they need to lead and inspire their troops. There is a heavy focus on preparing officers for an infantry platoon commander role.

Upon graduation from TBS, each USMC officer is assigned a four-digit code denoting their occupational field and specialty. Each career field is one of the Military Occupational Specialties (MOS). Some examples of different MOSs are artillery, public affairs, infantry, training, and financial management. It is essential for young USMC officers to build their knowledge of each MOS, because they are required to select five MOS preferences. A key element of TBS course is the understanding and awareness that officers receive in relation to the range of MOS choices.

The MOS assignment process is driven primarily by the needs of the USMC, with a secondary consideration for the individual Marine's preference. Prior to 1977, MOS allocation was based solely on an individual's overall standing at TBS. All lieutenants were ranked according to their overall average in military skills, academics, and leadership. Those with the best overall score received their first preference. In 1977, the Commandant of the USMC made the decision to apply a quality spread to the MOS assignment process. The Commandant devised a policy that would ensure each MOS received an appropriate share of both the high-performing and low-performing lieutenants. This policy is still in effect today, with TBS stating that one-third of the quotas for each MOS come from the top, middle, and bottom thirds of the performance list. Within each third, class standing is the primary assignment criterion. Lieutenants

near the top of their one-third have the best opportunity to receive one of their top choices. Lieutenants near the bottom of their one-third increment have a lesser chance.

## D. DATA AND VARIABLES

To ascertain whether there is any correlation between Corps allocation and retention required capturing a large amount of data. Unfortunately this data was not available from one central agency. To enable robust regression analysis, data was secured from two separate agencies and then merged into one data set. The two agencies that supplied data for this thesis were the Center for Naval Analyses (CNA) and the Total Force Data Warehouse (TFDW).

### 1. Center for Naval Analyses (CNA)

The CNA is a non-profit institution that conducts high-level, in-depth research and analysis to inform and shape the work of public sector decision makers. The CNA is a federally funded research and development center serving the Department of the Navy and other defense agencies. The CNA is responsible for collecting and storing a vast amount of Department of Defense (DoD) data. Included in the data maintained by CNA is panel data for USMC officers. Each officer's data file includes general demographic information, TBS academic performance, commissioning source, the top three MOS preferences, and the primary MOS.

### 2. Total Force Data Warehouse (TFDW)

The TFDW is the USMC knowledge management system that collects and maintains information on all USMC officers and enlisted members. TFDW data files were used to supplement the information that was obtained from CNA. Information that was drawn from the TFDW file and merged into the CNA file included length of service, commissioning sources, and pay levels (Blackman 2009).

A data extract from CNA and TFDW were merged, which resulted in 37,080 data points. The data set contained information on USMC officers from 1980 to 2006. The first step in refining the data was to remove fiscal years 1980 to 1993 and 2000. They

were removed because no MOS preference information was maintained during these years. The next step was to remove fiscal years 2003 to 2006, because officers were still bound by a return of service obligation during this period. The end result was a final sample size including data for 6,114 USMC officers.

## E. REGRESSION ANALYSIS

This research utilizes a computer program called Stata to run regressions on the USMC data. Stata is an integrated statistical package that enables data analysis and data management. The full range of data that was inputted into Stata included a wide range of demographic and service characteristics for each officer. A full list of each variable and its encoding within Stata is shown in Table 4.

Table 4. Variable Description

| **Category Variable** | **Description** | **Variable** | **Variable Type** | **Range** |
|---|---|---|---|---|
| DEPENDENT | | | | |
| | Retention to the 6-year point | Retained | Binary | 1 = Retained<br>0 = otherwise |
| INDEPENDENT | | | | |
| Demographics | Gender | Female | Binary | 1 = Female<br>0 = Male |
| | | Male | Binary | 1 = Male<br>0 = Female |
| | Race/Ethnicity | White | Binary | 1 = White<br>0 = otherwise |
| | | Black | Binary | 1 = Black<br>0 = otherwise |
| | | Asian | Binary | 1 = Asian<br>0 = otherwise |
| | | Hispanic | Binary | 1 = Hispanic<br>0 = otherwise |
| | Marital Status | Married | Binary | 1 = Married<br>0 = otherwise |
| | | Single | Binary | 1 = Single<br>0 = otherwise |
| | | Divorced | Binary | 1 = Divorced<br>0 = Otherwise |

| **Category Variable** | **Description** | **Variable** | **Variable Type** | **Range** |
|---|---|---|---|---|
| | Number of Dependents | Dependents | Continuous | Add 1 for each dependent |
| Service Info | Commissioning Source | USNA | Binary | 1 = USNA officer<br>0 = otherwise |
| | | NROTC | Binary | 1 = NROTC officer<br>0 = otherwise |
| | | PLC | Binary | 1 = PLC officer<br>0 = otherwise |
| | | OCC | Binary | 1 = OCC officer<br>0 = otherwise |
| | | MECEP | Binary | 1 = MECEP officer<br>0 = otherwise |
| | | ECP | Binary | 1 = ECP officer<br>0 = otherwise |
| | | MCP | Binary | 1 = MCP officer<br>0 = otherwise |
| | TBS Third | Top | Binary | 1 = Top third<br>0 = otherwise |
| | | Middle | Binary | 1 = Middle third<br>0 = otherwise |
| | | Lower | Binary | 1 = Bottom third<br>0 = otherwise |
| | GCT Score | GCT | Continuous | Add 1 for each additional point scored |
| | MOS Preference Received | First MOS | Binary | 1 = Received first MOS choice<br>0 = otherwise |
| | | Second MOS | Binary | 1 = Received second MOS choice<br>0 = otherwise |
| | | Third MOS | Binary | 1 = Received third MOS choice<br>0 = otherwise |
| | | Other MOS | Binary | 1 = Didn’t receive one of first 3 MOS choices<br>0 = otherwise |
| | Occupational Field | Combat Arms | Binary | 1 = Combat Arms MOS<br>0 = otherwise |

| **Category Variable** | **Description** | **Variable** | **Variable Type** | **Range** |
|---|---|---|---|---|
| | | Combat Service Support | Binary | 1 = CSS MOS<br>0 = otherwise |
| | | Air-Ground Support | Binary | 1 = Air-Ground Support MOS<br>0 = otherwise |
| | Primary Military Occupational Specialty | Primary MOS Code | Binary | 1 = PMOS<br>0 = otherwise |
| | Total GWOT and Non- GWOT Days Deployed | Days Deployed | Continuous Or Incrementa l | 100 Day Increments |
| | Education Status | Civmasters | Binary | 1=Ever Earned a Master’s Degree<br>0=otherwise |
| | Wounded in Action Status | WIA | Binary | 1=Wounded in Action 0=otherwise |
| | Retention Year Dummies | FY_00 to FY_08 | Binary | 1 = Fiscal Year<br>0 = otherwise |

Descriptive statistics are a useful snapshot of the data that is being analyzed. They provide the number of observations, mean, standard deviation, and the minimum and maximum values for each variable. A complete list of the descriptive statistics for the USMC data is shown in Table 5.

Table 5. Descriptive Statistics

| **Variable** | **Obs** | **Mean** | **Std. Dev.** | **Min** | **Max** |
|---|---|---|---|---|---|
| tbs_th | 6114 | 2.044652 | .8285762 | 1 | 3 |
| t_cl_std | 6114 | 119.1412 | 69.40322 | 1 | 287 |
| tbs_fy | 6114 | 1997.948 | 2.592593 | 1994 | 2002 |
| WIA | 6114 | .0157017 | .1243288 | 0 | 1 |
| Female | 6114 | .0904482 | .2868462 | 0 | 1 |

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Male | 6114 | .9095518 | .2868462 | 0 | 1 |
| White | 6114 | .8104351 | .3919888 | 0 | 1 |
| Black | 6114 | .0914295 | .2882425 | 0 | 1 |
| Hispanic | 6114 | .0785083 | .2689919 | 0 | 1 |
| Asian | 6114 | .0196271 | .1387264 | 0 | 1 |
| o2_married | 6114 | .4370298 | .4960595 | 0 | 1 |
| o2_single | 6114 | .5405626 | .4983927 | 0 | 1 |
| o2_divorced | 6114 | .0224076 | .1480171 | 0 | 1 |
| o2_depndts | 6114 | .6975793 | 1.06056 | 0 | 7 |
| GCT | 6114 | 124.2715 | 9.629784 | 99 | 159 |
| Civmasters | 6114 | .0973176 | .296414 | 0 | 1 |
| Top | 6114 | .3218842 | .4672371 | 0 | 1 |
| Middle | 6114 | .31158 | .4631771 | 0 | 1 |
| Lower | 6114 | .3665358 | .4818976 | 0 | 1 |
| MOSpr1 | 5837 | 1948.954 | 2399.669 | 0 | 7804 |
| MOSpr2 | 5837 | 1969.377 | 2309.453 | 0 | 7599 |
| MOSpr3 | 5836 | 2163.203 | 2361.63 | 0 | 7720 |
| PMOS | 6114 | 1764.542 | 2169.834 | 180 | 7220 |
| PR1 | 6114 | .4317959 | .4953669 | 0 | 1 |
| PR2 | 6114 | .1411515 | .3482062 | 0 | 1 |
| PR3 | 6114 | .0925744 | .2898588 | 0 | 1 |
| PRtop3 | 6114 | .6655218 | .4718463 | 0 | 1 |
| PRother | 6114 | .3344782 | .4718463 | 0 | 1 |

| **Variable** | **Obs** | **Mean** | **Std. Dev.** | **Min** | **Max** |
|---|---|---|---|---|---|
| m0302 | 6114 | .2219496 | .4155914 | 0 | 1 |
| m0802 | 6114 | .0917566 | .2887057 | 0 | 1 |
| m1302 | 6114 | .047105 | .2118808 | 0 | 1 |
| m1802 | 6114 | .0206084 | .1420811 | 0 | 1 |
| m1803 | 6114 | .0132483 | .1143455 | 0 | 1 |
| CA | 6114 | .394668 | .4888192 | 0 | 1 |
| m0180 | 6114 | .0448152 | .2069149 | 0 | 1 |
| m0202 | 6114 | .0006542 | .0255718 | 0 | 1 |
| m0203 | 6114 | .0340203 | .1812961 | 0 | 1 |
| m0204 | 6114 | .0063788 | .0796188 | 0 | 1 |
| m0206 | 6114 | .0210991 | .1437266 | 0 | 1 |
| m0207 | 6114 | .0202813 | .1409725 | 0 | 1 |
| m0402 | 6114 | .114982 | .3190263 | 0 | 1 |
| m0602 | 6114 | .0713117 | .2573659 | 0 | 1 |
| m2501 | 6114 | .0029441 | .0541837 | 0 | 1 |
| m2502 | 6114 | .0112856 | .1056411 | 0 | 1 |
| m3002 | 6114 | .0762185 | .2653691 | 0 | 1 |
| m3404 | 6114 | .031894 | .1757323 | 0 | 1 |
| m3502 | 6114 | .0193 | .1375884 | 0 | 1 |
| m4002 | 6114 | .0071966 | .0845339 | 0 | 1 |
| m4302 | 6114 | .0127576 | .112236 | 0 | 1 |
| m5803 | 6114 | .0209356 | .1431804 | 0 | 1 |
| CSS | 6114 | .4960746 | .5000255 | 0 | 1 |

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| m6002 | 6114 | .0274779 | .1634847 | 0 | 1 |
| m6602 | 6114 | .0210991 | .1437266 | 0 | 1 |
| m7204 | 6114 | .0073602 | .085482 | 0 | 1 |
| m7208 | 6114 | .0237161 | .1521755 | 0 | 1 |
| m7210 | 6114 | .016683 | .1280913 | 0 | 1 |
| m7220 | 6114 | .0112856 | .1056411 | 0 | 1 |
| m7201 | 6114 | .0016356 | .0404127 | 0 | 1 |
| AGS | 6114 | .1092574 | .3119875 | 0 | 1 |
| ECP | 6114 | .0001636 | .012789 | 0 | 1 |
| MCP | 6114 | .0176644 | .1317391 | 0 | 1 |
| MECEP | 6114 | .0487406 | .2153428 | 0 | 1 |
| OCC | 6114 | .3117435 | .4632436 | 0 | 1 |
| PLC | 6114 | .2690546 | .4435047 | 0 | 1 |
| NROTC | 6114 | .2317632 | .421993 | 0 | 1 |
| USNA | 6114 | .1208701 | .326003 | 0 | 1 |
| fy_00 | 6114 | .1081125 | .3105479 | 0 | 1 |
| fy_01 | 6114 | .117599 | .322159 | 0 | 1 |
| fy_02 | 6114 | .0987897 | .2984038 | 0 | 1 |
| fy_03 | 6114 | .1354269 | .342207 | 0 | 1 |
| fy_04 | 6114 | .1293752 | .3356422 | 0 | 1 |
| fy_05 | 6114 | .1442591 | .351381 | 0 | 1 |
| fy_07 | 6114 | .1432777 | .3503845 | 0 | 1 |
| fy_08 | 6114 | .12316 | .3286476 | 0 | 1 |

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| SEP | 6114 | .0062152 | .0785979 | 0 | 1 |
| FAO | 6114 | .0003271 | .0180849 | 0 | 1 |
| RAO | 6114 | .0001636 | .012789 | 0 | 1 |
| IAOP | 6114 | .0004907 | .0221476 | 0 | 1 |
| Prior | 6114 | .328263 | .4696195 | 0 | 1 |
| Retained | 6114 | .1746811 | .3797251 | 0 | 1 |
| Daysdepl | 6114 | 3.309944 | 2.949481 | 0 | 21 |
| Rank | 6114 | 3500.66 | 2030.48 | 1 | 7044 |

Only the key variables were selected for inclusion in the retention model. The choice of variables was guided by the information that was obtained during the literature review. The literature review highlighted several factors that were correlated with employee retention, both in the military and civilian communities. The following seven variables were chosen:

a. MOS preference achievement,

b. Gender,

c. Race / ethnicity,

d. Marital status,

e. Number of dependents,

f. Prior enlisted history, and

g. Education.

The dependant variable that was developed was a binary variable for retention of the six years. The variable is defined as "one" if the officer has six or more years of service and "zero" if the officer has less than six years service. A period of six years was chosen because the minimum service requirement is either four or five years, depending

on commissioning source. A six-year dependant variable allows for the variance in operational requirements, individual circumstances, and service extensions.

The model that was developed was a simple linear probability model (a multiple linear regression model with a binary dependant variable). It can be expressed in the following manner:

> Retained 6 years = β1*MOS first Preference Achievement + β2*MOS second Preference Achievement + β3*MOS Preference Achievement not in top 3 + β4*White + β5*Black + β6*Hispanic + β7*Married + β8*Number of Dependents + β9*Prior Enlisted + β7*Education (civilian masters) + β8*FY dummy variables + u

When the model was run in Stata, the results showed that there are significant differences between the retention dynamics of USMC officers who receive their first MOS preference and those who were allocated to an MOS that was outside of their top three choices. The independent variable for first MOS preference is positive and significant at a 10% level of significance; the coefficient for receiving first MOS is 0.05299. The independent variable for second MOS preference is slightly negative with a coefficient of -0.01122. The independent variable for other MOS preferences (outside the top three) is negative and significant at a 10% level of significance; the coefficient for receiving other MOS preference is -0.01408.

The results from the regression analysis show the overall goodness-of-fit of the model is reasonable as the R-squared value is 0.31. An R-squared value of 0.31 means that for the USMC officers who remained serving until the six year mark, 31% of the reason why they remained is explained by the variables contained in the model. This result is quite strong when consideration is given to the wide range of factors that shape retention. A full summary of the regression results from Stata are contained in Table 6.

Table 6. Regression Results: Retained to Six Years after Commissioning

| **Retained** | **Coef.** | **Std. Err.** | **t** | **P>t** | **[95% Conf. Interval]** | |
|---|---|---|---|---|---|---|
| PR1 | .0529902 | .0146892 | 0.36 | 0.071 | -.0234968 | .0340951 |
| PR2 | -.0112213 | .0171423 | -0.95 | 0.344 | -.0498263 | .0173837 |
| PRother | -.0140822 | .0151428 | -0.93 | 0.092 | -.0437675 | .0156031 |
| White | -.0367105 | .0293285 | -1.25 | 0.211 | -.0942046 | .0207837 |
| Black | -.0433671 | .0319521 | -1.36 | 0.175 | -.1060046 | .0192704 |
| Hispanic | -.0599217 | .0323702 | -1.85 | 0.064 | -.1233788 | .0035353 |
| o2_married | .0780739 | .0116064 | 6.73 | 0.000 | .0553212 | .1008265 |
| o2_depndts | -.0149546 | .0056986 | -2.62 | 0.009 | -.0261258 | -.0037834 |
| Prior | .0327939 | .0095865 | 3.42 | 0.001 | .0140011 | .0515867 |
| Civmasters | .220412 | .0139416 | 15.81 | 0.000 | .1930815 | .2477426 |
| fy_00 | -.0177122 | .018145 | -0.98 | 0.329 | -.0532829 | .0178584 |
| fy_01 | -.0328364 | .0176147 | -1.86 | 0.062 | -.0673674 | .0016946 |
| fy_03 | -.2088375 | .0170232 | -12.27 | 0.000 | -.242209 | -.175466 |
| fy_04 | -.4350163 | .0171521 | -25.36 | 0.000 | -.4686404 | -.4013922 |
| fy_05 | -.4403418 | .0167816 | -26.24 | 0.000 | -.4732396 | -.4074441 |
| fy_07 | -.4256419 | .0169134 | -25.17 | 0.000 | -.4587981 | -.3924858 |
| fy_08 | -.4232119 | .017459 | -24.24 | 0.000 | -.4574377 | -.3889861 |
| _cons | .4288801 | .0345901 | 12.40 | 0.000 | .3610713 | .4966888 |

| Source | SS | df | MS |
|---|---|---|---|
| Model | 270.4 | 17 | 15.911332 |
| Residual | 610.9 | 6096 | .100221126 |
| Total | 881.4 | 6113 | .144191171 |

Number of obs = 6114
F( 17, 6096) = 158.76
Prob > F = 0.0000
R-squared = 0.3069
Adj R-squared = 0.3049
Root MSE = .31658

The regression significance results from the Stata regression are contained in Table 7.

Table 7. Regression Significance: Retained to Six Years after Commissioning

| | |
|---|---|
| PR1 | 0.0530* |
| | (0.0147) |
| PR2 | -0.0162 |
| | (0.0171) |
| PRother | -0.041* |
| | (0.051) |
| White | -0.0367 |
| | (0.0293) |
| Black | -0.0434 |
| | (0.0320) |
| Hispanic | -0.0599* |
| | (0.0324) |
| o2_married | 0.0781*** |
| | (0.0116) |
| o2_depndts | -0.0150*** |
| | (0.00570) |
| Prior | 0.0328*** |
| | (0.00959) |
| Civmasters | 0.220*** |
| | (0.0139) |
| fy_01 | -0.0151 |
| | (0.0173) |
| fy_02 | 0.0177 |
| | (0.0181) |

| | |
|---|---|
| fy_03 | -0.191*** |
| | (0.0167) |
| fy_04 | -0.417*** |
| | (0.0170) |
| fy_05 | -0.423*** |
| | (0.0166) |
| fy_07 | -0.408*** |
| | (0.0167) |
| fy_08 | -0.405*** |
| | (0.0172) |
| Constant | 0.411*** |
| | (0.0345) |

| | |
|---|---|
| Observations | 6114 |
| R-squared | 0.307 |

Standard errors in parentheses
Significant at 1%*** p<0.01
Significant at 5%** p<0.05,
Significant at 10%* p<0.1

## F. SUMMARY AND CONCLUSION

The regression results contained in Tables 6 and 7 are the result of a linear probability model. They measured the change in probability of success (retention) when the variables changed, holding all other factors constant or fixed. The results showed that remaining in the military beyond an MSO was positively affected by receiving a first MOS preference, prior service, being a male, being married, and having a master's degree. Remaining in the military beyond an MSO was negatively affected by the following factors: receiving an MOS outside the top three preferences, being Hispanic, and having a higher number of dependents.

The military is like any organization in that officer retention is a critical element of manpower planning. The importance of officer retention is further reinforced by the very nature of military recruiting systems. There is very limited lateral entry into the system, and it is therefore essential to recruit, promote, retain, and discharge an appropriate number of personnel. The results from the six-year regression model verified that the allocation of cadets to an MOS is a very important element within the retention framework of military officers. Many of the men and women who choose to enter the military have a specific MOS that they desire to serve within; not being allocated to this

MOS can be a shattering experience. Failing to secure a high MOS preference significantly and negatively impacts retention beyond an officer's minimum service obligation. It is essential that officer accession sources maximize the number of cadets who receive a high-order MOS preference.

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# IV. ROYAL MILITARY COLLEGE MODELING ANALYSIS

## A. SCOPE

The purpose of this chapter is to define the Australian Army corps allocation process and to develop models that optimize both organizational and individual outcomes. Firstly, the chapter will cover the Corps' allocation process that currently occurs at the Royal Military College Duntroon (RMC). Secondly, this chapter will develop models that will allow RMC staff to detail weighting for specific variables whilst also maximizing the percentage of staff cadets (cadets) receiving their first or second corps preference.

The cost of training each cadet to become a junior officer in the Australian Army is extremely high. It is imperative every effort is made to provide each cadet with a rewarding career in their chosen field. The first step in this process is achieving a corps allocation that maximizes the cadet's preferences whilst also meeting the requirements of Army. Accurate models are needed to help the Australian Army develop corps allocation processes that will retain a sufficient number of officers who have the right qualities.

## B. BACKGROUND

In 1974, the decision was made that all initial Army officer training would be centralized at RMC. Accordingly, in 1986, RMC took over the training responsibilities from all other full-time Army officer training establishments, including the Officer Cadet School at Portsea, Victoria; the Women's Officer Training Wing at Georges Heights, Sydney, New South Wales; and the Specialist Officer training wing at Canungra, Queensland. Beginning in 1986, RMC has provided a course of between 12–18 months in duration. Upon graduation from RMC, cadets are commissioned as lieutenants in the Australian Army.

Generally, direct intakes occur every January and July, and all direct-entry cadets undertake an 18-month training program. New officer candidates enlist as third-class cadets and progress to second-class cadets after six months; they become first-class

cadets after 12 months. Graduates of the Australian Defence Force Academy (ADFA) join at the beginning of each calendar year and are amalgamated with the new second-class cadets. The RMC direct-entry cadets and ADFA graduates then spend their final 12 months of officer training together.

The charter of RMC is to prepare cadets and other selected candidates for careers in the Army. Cadets are prepared for their careers via leadership training that promotes integrity, high ideals, the pursuit of excellence, and a sense of duty, loyalty, and service to the nation. The mission of RMC is to produce officers capable of commanding platoon groups in the hardened and networked Army and to prepare specialist candidates for commissioning. Toward the end of their time at RMC, each cadet nominates four corps in which they would like to serve upon graduation. The cadets list the corps in order from most desired to least desired.

The RMC structure includes the following elements:

- Headquarters RMC—including the Commandant , Director of Military Art and the Director of Army Reserve Training;
- Military Art and Training Wing;
- Army Reserve Training Development Wing; and
- Corps of Staff Cadets (which consists of the five cadet Companies).

## C. CURRENT PROCESS

Allocating cadets to a specific corps is handled by the Corps Allocation Board (CAB). The CAB is generally comprised of the following personnel: RMC staff, Directorate of Officer Career Management (DOCM-A) staff, and members from the Directorate of Personnel Army (DPERS-A). The purpose of the CAB is to assign cadets to a specific corps fairly whilst adhering to the manning requirements. The process is intended to give due regard to cadet preferences whilst adhering to the manning requirements. The following factors are to be considered in relation to each cadet's corps allocation:

a. army manning requirements;

b. cadet preferences;

c. assessment of the person as a whole, including:

    (1) officer qualities,

    (2) academic performance,

    (3) performance fit,

    (4) participation,

    (5) leadership and teamwork,

    (6) conduct, and

    (7) negative selection (i.e., CP3[3]).

d. distribution of ability;

e. gender proportionality (where applicable), and

f. medical restrictions.

## D. OPTIMIZATION MODELING

Optimization modeling is a type of mathematical modeling that attempts to optimize (maximize or minimize) an objective function without violating resource constraints. In essence, optimization modeling finds the answer that yields the best result, given the specified constraints. It could be the answer that attains the highest profit, output, or utility. Alternatively, it could be the answer that achieves the lowest cost, waste, or minimizes losses. Optimization problems often involve making the most efficient use of a finite resource. The resources could be money, time, machine hours, labor, inventory, office space, or job functions. The range of optimization problems is as wide as the range of techniques available to solve them. Optimization problems are often classified as either linear or nonlinear, depending on whether the objectives and

[3] Color blindness

constraints in the problem are linear with respect to the variables. There are a variety of software packages to solve optimization problems. This thesis will utilize an optimization tool that is inbuilt within Microsoft (Excel): the program is called “solver.”

All optimization models that utilize solver are defined by the following three elements:

a. decision variables (changing cells),

b. objective function, and

c. constraints.

Figure 1 shows how the solver parameters are displayed in Excel.

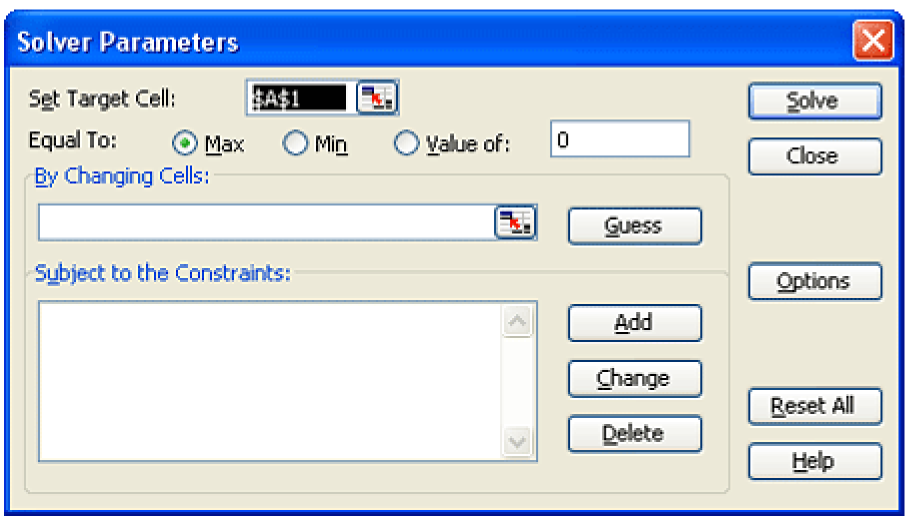



Figure 1. Solver Parameters

The basic goal of solver is to adjust the value of the decision variables to either minimize or maximize the objective function while satisfying the constraints. A solution value for decision variables, where all of the constraints are satisfied, is called a feasible solution. The way solver processes an optimization problem is by first finding a feasible solution, then seeking to improve upon it, and finally changing the decision variables to move from one feasible solution to a better feasible solution. This process is repeated until the objective function has reached its maximum or minimum; this result is called an

optimal solution. For the objective function to describe the behavior of the measure of effectiveness, it must capture the relationship between that measure and the decision variables that cause it to change. A decision variable is a variable that can be directly controlled by the decision maker.

### 1. Decision Variables

Decision variables are the cells on the Excel spreadsheet that the decision maker can change or adjust to optimize the target cell. The cells in which these amounts are recorded are the changing cells in this model. They usually measure the resources, such as money, to be allocated to an activity. In this thesis, the decision variables are the corps' assignments for each individual cadet. Therefore, the total number of decision variables equals the number of different corps available multiplied by the number of cadets who need to be allocated to a corps. The decision variables are binary, assuming a value of one if the cadet is assigned to that corps and zero otherwise. The vast number of decision variables highlights the difficulty of the corps' allocation process.

### 2. Objective Function

Once you have defined the decision variables, the next step is to define the objective function. The objective function depends on the decision variables. In this thesis, the objective function has been formulated as a maximizing cell that is increased by higher cadet preference achievement.

### 3. Defining Constraints

In most models, constraints play a key role in determining what values the decision variables can assume and what objective values can be attained. Constraints are restrictions you place on the changing cells. To define a constraint, you first compute a value based on the decision variables. Then, you place a limit (<=, = or >=) on this computed value. In this thesis, the key constraint is the number of positions that are available in each corps. Therefore, the constraint will be expressed as sum of decision variables (cadets allocated to corps A) = the value of the constraint (number of positions available with corps A).

Solver also allows you to specify that all decision variables are integers (whole numbers). A particularly useful type of integer constraint specifies that a variable must have an integer value with a lower bound of 0, and an upper bound of 1. This forces the variable to be either 0 or 1, hence it can be used to model "yes / no" decisions. This type of constraint was essential to this thesis as each decision variable needed to be an integer, either a cadet was allocated to corps A or they were not allocated to corps A.

#### 4. Interpreting Solver Solutions

A solution or set of values for the decision variables in which all of the constraints in the Solver model are satisfied is called a "feasible solution." Solver attempts to firstly find a feasible solution and then improve it by finding another feasible solution that increases (or decreases) the value of the objective function. An optimal solution is a feasible solution wherein the objective function reaches a maximum (or minimum) value.

Data was obtained from RMC for cadets who graduated in 2008 and 2009. This data contained a complete list of each cadet's: corps preferences, actual allocation, and Queens medal score. This data will be used to build models that maximize cadet preferences whilst also meeting service requirements.

## E. DATA

The benchmark data that the optimization models were compared against is actual corps preferences and allocations from the 2008 and 2009 RMC graduating classes. The only modification made to the data is to:

a. remove all foreign student (the do not receive a corps allocation), and
b. names have been replaced with numbers (to ensure privacy).

#### 1. 2008 Data

Data was obtained from the RMC graduating class of 2008. Table 8 shows a breakdown of each cadet's actual allocation, corps preferences and preference achievement.

Table 8. Corps Preferences and Allocation (2008)

| **Name** | **Actual** | **First Pref** | **Second Pref** | **Third Pref** | **Fourth Pref** | **Pref achievement** |
|---|---|---|---|---|---|---|
| 1 | AAAVN | AAAVN | AUSTINT | RAAMC | RACT | 1 |
| 2 | AAAVN | AAAVN | RAINF | RAAC | RAE | 1 |
| 3 | AAAVN | AAAVN | RAEME | NIL | NIL | 1 |
| 4 | AUSTINT | AUSTINT | RAAC | RASIGS | RAAMC | 1 |
| 5 | AUSTINT | AUSTINT | RACT | RAAOC | RAE | 1 |
| 6 | AUSTINT | AUSTINT | RAAC | RACMP | RAINF | 1 |
| 7 | AUSTINT | AUSTINT | RASIGS | RACT | RAEME | 1 |
| 8 | AUSTINT | AUSTINT | RAE | RACT | RASIGS | 1 |
| 9 | AUSTINT | AUSTINT | RAAC | RACT | RAAOC | 1 |
| 10 | AUSTINT | AUSTINT | RASIGS | RAAMC | RACT | 1 |
| 11 | AUSTINT | AUSTINT | RASIGS | RAAMC | RACT | 1 |
| 12 | RAA | RAA | RAEME | RASIGS | AAAVN | 1 |
| 13 | RAA | RAA | RAAC | RAINF | AUSTINT | 1 |
| 14 | RAA | RAA | RAEME | RACT | RACMP | 1 |
| 15 | RAA | RAAMC | RASIGS | RAE | AUSTINT | 5 |
| 16 | RAA | RAAC | RAA | RASIGS | RACT | 2 |
| 17 | RAA | AUSTINT | RAINF | RAA | RAAC | 3 |
| 18 | RAA | RAA | RAAC | RASIGS | RACT | 1 |
| 19 | RAA | RAA | RACMP | RAINF | RAEME | 1 |
| 20 | RAA | RAINF | RAE | RASIGS | RAA | 4 |
| 21 | RAA | RACMP | RACT | RAA | RASIGS | 3 |
| 22 | RAAC | RAINF | RAAC | RAE | RACT | 2 |
| 23 | RAAC | RAAC | AUSTINT | RAE | RACT | 1 |
| 24 | RAAC | RAINF | RAAC | AUSTINT | RAAMC | 2 |
| 25 | RAAC | RAAC | RAE | RAINF | RACT | 1 |
| 26 | RAAC | RAINF | RAAC | RACMP | AUSTINT | 2 |
| 27 | RAAC | RAAC | RAINF | AUSTINT | RAE | 1 |
| 28 | RAAC | RAINF | RAAC | RAAOC | RAE | 2 |
| 29 | RAAC | RAAC | RAINF | RACT | RAAOC | 1 |
| 30 | RAAMC | RAAMC | RASIGS | RACT | RACMP | 1 |
| 31 | RAAMC | RAAMC | RAINF | RAAC | AUSTINT | 1 |
| 32 | RAAOC | RAE | RASIGS | RACT | RAAOC | 4 |
| 33 | RAAOC | RAAOC | RACT | RAAMC | RAA | 1 |

| Name | Actual | First Pref | Second Pref | Third Pref | Fourth Pref | Pref achievement |
|---|---|---|---|---|---|---|
| 34 | RAAOC | RAAOC | RACT | RASIGS | RAEME | 1 |
| 35 | RAAOC | RAAOC | RACT | RACMP | RASIGS | 1 |
| 36 | RAAOC | RASIGS | RAAOC | RACT | RACMP | 2 |
| 37 | RAAOC | RAAOC | RASIGS | RAE | RACMP | 1 |
| 38 | RAAOC | AUSTINT | RASIGS | RACT | N/A | 5 |
| 39 | RAAOC | AUSTINT | RAA | RASIGS | RAAC | 5 |
| 40 | RAAOC | RACMP | RAAOC | RAE | RASIGS | 2 |
| 41 | RAAOC | RAAOC | RACT | RASIGS | RAAMC | 1 |
| 42 | RACMP | RACMP | RACT | RAAMC | RAAOC | 1 |
| 43 | RACMP | RACMP | RACT | RAAOC | RAEME | 1 |
| 44 | RACMP | RACMP | RAE | AUSTINT | RAAC | 1 |
| 45 | RACMP | RAINF | RAAC | RACMP | RAE | 3 |
| 46 | RACT | RACT | RAE | RAEME | RAAOC | 1 |
| 47 | RACT | RASIGS | RACT | RAAOC | RAEME | 2 |
| 48 | RACT | AUSTINT | RACT | RAE | RASIGS | 2 |
| 49 | RACT | RACT | AUSTINT | RAEME | RAAOC | 1 |
| 50 | RACT | RACT | RASIGS | RACMP | RAAOC | 1 |
| 51 | RACT | RAAC | RACT | RAE | RASIGS | 2 |
| 52 | RACT | RACT | RAAMC | RAAOC | RACMP | 1 |
| 53 | RACT | AUSTINT | RASIGS | RACT | RAAOC | 3 |
| 54 | RACT | RAAMC | RACT | RAAOC | AUSTINT | 2 |
| 55 | RACT | RACT | RAAOC | RACMP | RASIGS | 1 |
| 56 | RAE | RAINF | RAE | RAAC | RACMP | 2 |
| 57 | RAE | RAAC | RAE | RAINF | RACMP | 2 |
| 58 | RAE | RAE | RAINF | RASIGS | RAAOC | 1 |
| 59 | RAE | RAINF | AUSTINT | RAAC | RAE | 4 |
| 60 | RAE | RAE | AUSTINT | RAAC | RASIGS | 1 |
| 61 | RAE | RAE | RACT | RAAOC | RASIGS | 1 |
| 62 | RAE | RAE | RAAC | RAINF | AUSTINT | 1 |
| 63 | RAE | RAA | RAE | RASIGS | RAAMC | 2 |
| 64 | RAEME | RAINF | RACT | RAEME | RASIGS | 3 |
| 65 | RAEME | RAAC | RASIGS | RACT | RAEME | 4 |
| 66 | RAEME | RAEME | RACC | RAPC | AUSTINT | 1 |
| 67 | RAEME | RAEME | RASIGS | RAAOC | RACT | 1 |
| 68 | RAEME | AUSTINT | RASIGS | RACT | RAEME | 4 |

| Name | Actual | First Pref | Second Pref | Third Pref | Fourth Pref | Pref achievement |
|---|---|---|---|---|---|---|
| 69 | RAEME | RAAC | RACT | RAEME | RAAOC | 3 |
| 70 | RAINF | RAINF | AUSTINT | RAAC | RACMP | 1 |
| 71 | RAINF | RAINF | AUSTINT | RAAC | RAAMC | 1 |
| 72 | RAINF | RAINF | RAAC | RASIGS | AUSTINT | 1 |
| 73 | RAINF | RAINF | RAAC | RAE | RACMP | 1 |
| 74 | RAINF | RAINF | RAE | RAAC | AUSTINT | 1 |
| 75 | RAINF | RAINF | RAAC | AUSTINT | RACMP | 1 |
| 76 | RAINF | RAINF | RAAC | RACMP | RAE | 1 |
| 77 | RAINF | RAINF | RAAC | AUSTINT | RASIGS | 1 |
| 78 | RAINF | RAINF | RACMP | RASIGS | RACT | 1 |
| 79 | RAINF | RAINF | RAAC | AUSTINT | RASIGS | 1 |
| 80 | RAINF | RAINF | RAAC | RAAMC | AUSTINT | 1 |
| 81 | RAINF | RAINF | RAEME | RACT | RAE | 1 |
| 82 | RAINF | RAINF | AUSTINT | RAAC | RASIGS | 1 |
| 83 | RAINF | RAINF | RAAC | AAAVN | RAE | 1 |
| 84 | RAINF | RAINF | RAAC | RAE | AUSTINT | 1 |
| 85 | RASIGS | RASIGS | AUSTINT | RAAOC | RACT | 1 |
| 86 | RASIGS | RASIGS | RAAMC | RACT | RAAOC | 1 |
| 87 | RASIGS | RASIGS | RACT | RAAOC | AUSTINT | 1 |
| 88 | RASIGS | RAE | RASIGS | RAEME | RAAOC | 2 |
| 89 | RASIGS | RAE | RAA | RAAMC | RAAOC | 5 |
| 90 | RASIGS | RASIGS | RAEME | AUSTINT | RAAOC | 1 |
| 91 | RASIGS | RASIGS | RAINF | RAA | RAAOC | 1 |
| 92 | RASIGS | RASIGS | AUSTINT | RAAOC | RACT | 1 |
| 93 | RASIGS | RASIGS | RACT | RAAMC | RAAC | 1 |
| 94 | RASIGS | RASIGS | AUSTINT | RACMP | RAAOC | 1 |

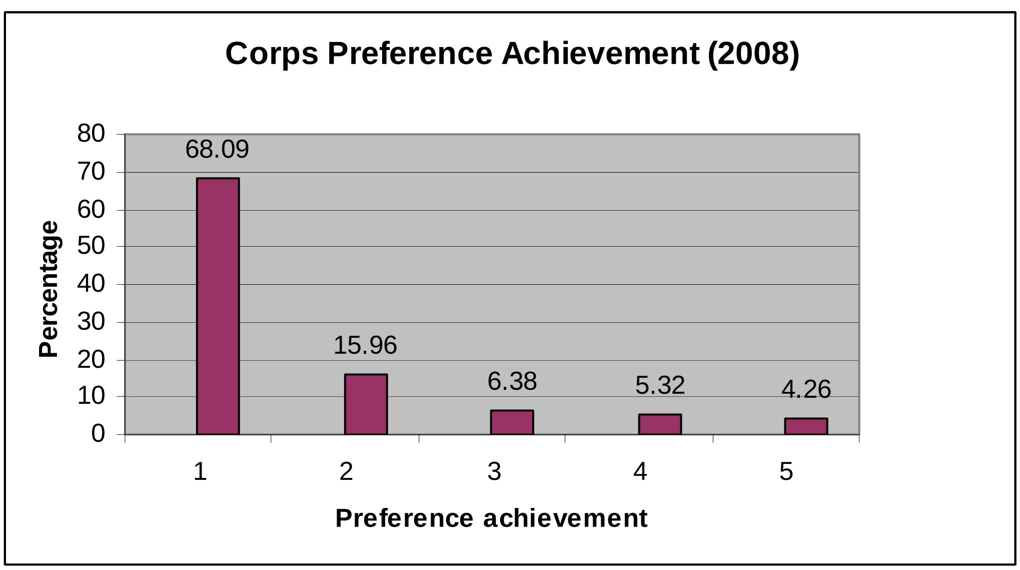
A summary of the actual preference breakdown for 2008 is contained in Table 9.

Table 9. Actual Preference Achievement (2008)

| **Summary** | **Number** | **Percentage** |
|---|---|---|
| First preference | 64 | 68.09% |
| Second preference | 15 | 15.96% |
| Third preference | 6 | 6.38% |
| Fourth preference | 5 | 5.32% |
| Other (5) | 4 | 4.26% |
| | **94** | **100%** |

A graphical representation of the actual preference breakdown for 2008 is contained in Table 10.

Table 10. Graphical Preference Achievement (2008)



### 2. 2009 Data

Data was obtained from RMC graduating class of 2009. Table 11 shows a each cadet's corps allocation, corps preferences, and preference achievement.

Table 11. Cadet Preferences and Corps Allocation for RMC (2009)

| Name | Actual | First Pref | Second Pref | Third Pref | Fourth Pref | Pref achievement |
|---|---|---|---|---|---|---|
| 1 | AAAVN | AAAVN | RAAC | RAE | RASIGS | 1 |
| 2 | AAAVN | AAAVN | RAE | RAEME | RAA | 1 |
| 3 | AAAVN | AAAVN | AUSTINT | RAAC | RASIGS | 1 |
| 4 | AAAVN | AAAVN | RACT | RAE | RACMP | 1 |
| 5 | AAAVN | AAAVN | AUSTINT | RAE | RACMP | 1 |
| 6 | AAAVN | AAAVN | RAAC | RAINF | RAA | 1 |
| 7 | AAAVN | AAAVN | RAINF | RAAC | RAEME | 1 |
| 8 | AACC | AACC | RACT | RAAMC | RAAOC | 1 |
| 9 | AACC | AACC | RASIGS | RACT | RAAOC | 1 |
| 10 | AUSTINT | AUSTINT | RAE | RAEME | RACT | 1 |
| 11 | AUSTINT | AUSTINT | RAEME | RASIGS | RACT | 1 |
| 12 | AUSTINT | AUSTINT | RASIGS | RAE | RACT | 1 |
| 13 | AUSTINT | AUSTINT | RAAC | RAAOC | RAEME | 1 |
| 14 | AUSTINT | AUSTINT | RASIGS | RACT | RAEME | 1 |
| 15 | AUSTINT | AUSTINT | RAE | RASIGS | RAAC | 1 |
| 16 | AUSTINT | AUSTINT | RASIGS | RACT | RAAMC | 1 |
| 17 | RAA | RAAC | RAA | RACMP | RAEME | 2 |
| 18 | RAA | RAA | RACT | RAEME | RASIGS | 1 |
| 19 | RAA | RAA | RACT | RAAOC | RASIGS | 5 |
| 20 | RAA | RAA | RACT | RAE | RACMP | 1 |
| 21 | RAA | RAA | RAINF | RAE | RAEME | 1 |
| 22 | RAA | RAA | AUSTINT | RAINF | RACMP | 1 |
| 23 | RAA | RAAC | RAINF | RAA | RACT | 5 |
| 24 | RAAC | RAAC | RAE | RAEME | RASIGS | 1 |
| 25 | RAAC | RAAC | RAINF | RAE | RACT | 1 |
| 26 | RAAC | RAAC | RAINF | RAA | RACT | 1 |
| 27 | RAAC | RAAC | RASIGS | RAE | RACMP | 1 |
| 28 | RAAC | RAAC | RAINF | AUSTINT | RAE | 1 |

| Name | Actual | First Pref | Second Pref | Third Pref | Fourth Pref | Pref achievement |
|---|---|---|---|---|---|---|
| 29 | RAAC | RAAC | RAINF | RAE | RACMP | 1 |
| 30 | RAAMC | RAAMC | RAAOC | AUSTINT | RACT | 1 |
| 31 | RAAMC | RAAMC | RAAOC | RACT | RAE | 1 |
| 32 | RAAOC | RAAOC | RASIGS | RACT | RAE | 1 |
| 33 | RAAOC | RAAOC | RACT | RAEME | RAE | 1 |
| 34 | RAAOC | RASIGS | AUSTINT | RAE | RACT | 5 |
| 35 | RAAOC | RACT | RAAOC | RAEME | RASIGS | 2 |
| 36 | RAAOC | RAAOC | RAEME | RACT | RAAMC | 1 |
| 37 | RAAOC | AUSTINT | RAAC | RAINF | RAEME | 5 |
| 38 | RAAOC | RAAC | RAAOC | RAEME | RACT | 2 |
| 39 | RACMP | RACMP | RASIGS | RAE | RAEME | 1 |
| 40 | RACMP | RAINF | RACMP | RAA | RAAOC | 2 |
| 41 | RACMP | RACMP | RAINF | RACT | RAE | 1 |
| 42 | RACT | RACT | RASIGS | AUSTINT | RAAMC | 1 |
| 43 | RACT | RACT | RAE | RAAOC | RASIGS | 1 |
| 44 | RACT | RAE | RACT | RAEME | RASIGS | 2 |
| 45 | RACT | RACT | RAAMC | RAAOC | AUSTINT | 1 |
| 46 | RACT | RAE | RACT | RAEME | AUSTINT | 2 |
| 47 | RAE | RAE | AUSTINT | RAAC | RAA | 1 |
| 48 | RAE | RAE | RAEME | RACT | RAA | 1 |
| 49 | RAE | RAE | RASIGS | RACT | RAA | 1 |
| 50 | RAE | RAE | RASIGS | RAA | AAAVN | 1 |
| 51 | RAE | RAE | RAAC | RAINF | AUSTINT | 1 |
| 52 | RAE | RAAC | RAE | RAA | RACT | 5 |
| 53 | RAEME | RAEME | AUSTINT | RASIGS | RAE | 1 |
| 54 | RAEME | RAEME | RACT | RAAOC | RASIGS | 1 |
| 55 | RAEME | RAE | RAEME | RACT | RAA | 2 |
| 56 | RAEME | RAE | RAEME | RASIGS | RAA | 2 |
| 57 | RAEME | RAEME | RAAC | RASIGS | RACMP | 1 |
| 58 | RAEME | RAE | RAEME | RACT | RASIGS | 2 |
| 59 | RAEME | RAE | RAEME | RASIGS | RACT | 2 |
| 60 | RAEME | RAE | RAEME | RACT | RAA | 2 |
| 61 | RAINF | RAINF | RAAC | RAE | RACT | 1 |
| 62 | RAINF | RAINF | RAAC | RAE | RAA | 1 |
| 63 | RAINF | RAINF | RAAC | RACMP | RAE | 1 |

| Name | Actual | First Pref | Second Pref | Third Pref | Fourth Pref | Pref achievement |
|---|---|---|---|---|---|---|
| 64 | RAINF | RAINF | RAAC | AUSTINT | RACMP | 1 |
| 65 | RAINF | RAINF | AUSTINT | RACT | RAE | 1 |
| 66 | RAINF | RAINF | RAAC | RAE | RAA | 1 |
| 67 | RAINF | RAINF | RAAOC | RAA | RAE | 1 |
| 68 | RAINF | RAINF | RAAC | RAE | RAAMC | 1 |
| 69 | RAINF | RAINF | RAAC | RAE | RACT | 1 |
| 70 | RAINF | RAINF | RAAC | RAA | RACT | 1 |
| 71 | RAINF | RAINF | AUSTINT | RAAC | RAE | 1 |
| 72 | RAINF | RAINF | RAAC | RAA | RACT | 1 |
| 73 | RAINF | RAINF | RAE | RAEME | RACT | 1 |
| 74 | RASIGS | RASIGS | AUSTINT | RAINF | RAAOC | 1 |
| 75 | RASIGS | RASIGS | AUSTINT | RAINF | RAEME | 1 |
| 76 | RASIGS | AUSTINT | RAA | RASIGS | RAEME | 3 |
| 77 | RASIGS | RAA | RASIGS | RAEME | RACT | 2 |
| 78 | RASIGS | RASIGS | RACMP | RAA | RAEME | 1 |
| 79 | RASIGS | RAAMC | RACT | RASIGS | RACMP | 3 |
| 80 | RASIGS | RASIGS | RAE | RACT | RAAOC | 1 |
| 81 | RASIGS | AUSTINT | RASIGS | RAE | RAEME | 2 |
| 82 | RASIGS | RAE | RASIGS | RACT | RAAOC | 2 |

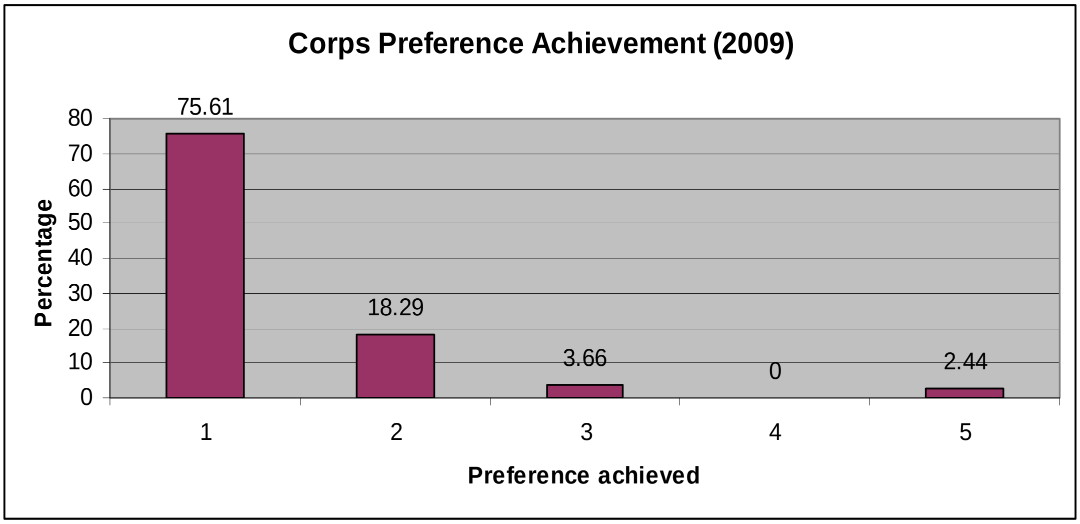
A summary of the actual preference breakdown for 2009 is contained in Table 12.

Table 12. Preference Achievement (2009)

| Summary | Number | Percentage |
|---|---|---|
| First preferences | 62 | 75.61% |
| Second preferences | 15 | 18.29% |
| Third preferences | 3 | 3.66% |
| Fourth preferences | 0 | 0.00% |
| Other | 2 | 2.44% |
| | **82** | **100.00%** |

A graphical representation of the actual preference achievement for 2009 is contained in Table 13.

Table 13. Graphical Preferences Achievement (2009)



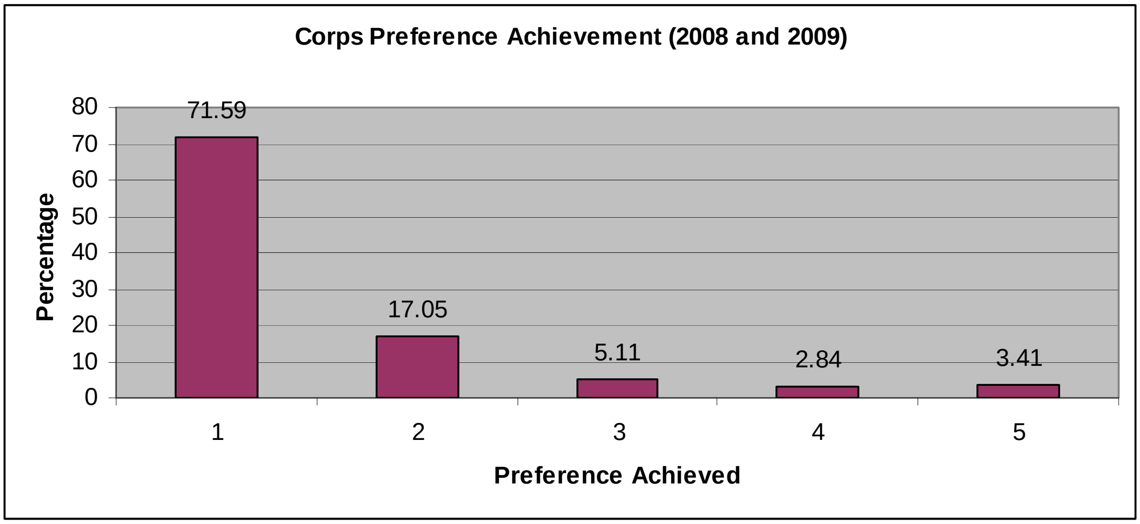

A summary of the actual preference achievement over the period 2008 / 2009 is contained in Table 14.

Table 14. Preference Achievement (2008 and 2009)

| **Summary** | **Number** | **Percentage** |
|---|---|---|
| First preferences | 126 | 71.59% |
| Second preferences | 30 | 17.05% |
| Third preferences | 9 | 5.11% |
| Fourth preferences | 5 | 2.84% |
| Other | 6 | 3.41% |
| | **176** | **100.00%** |

A graphical representation of the actual preference achievement for 2008 / 2009 is contained in Table 15.

Table 15. Graphical Preferences Achievement (2008 /2009)




## F. MODEL ASSESSMENT

In order to effectively rank and assess optimization models, it is useful to define a set of criteria that they will be assessed against. Chapter II concluded that the majority of academics concur that recognition and reward of performance are important elements of the retention dynamic. Therefore, "performance recognition" will be one of the factors against which each model will be assessed. Chapter III developed a linear probability model that utilized USMC data. The results showed that remaining in the military beyond a minimum service obligation was positively affected by receiving your first Military Occupational Specialties (MOS) preference, and was negatively affected by receiving a lower order MOS preference. Therefore, "maximizing first preferences" and "minimizing third, fourth and no preference" will both be categories that the models will be assessed against. Each model will be given a score of either: high, medium or low in relation to each of the three assessment categories. If a model performs well in relation to a category it will receive a grading of high, and if it performs poorly it will be assessed a grading of low.

## G. MODEL 1 (WEIGHTED FOR CADET PREFERENCE)

The first optimization model that was developed utilized the number of positions that were available and sought to maximize the number of cadets receiving an allocation that was highest in their preferences. The inputs to the model were decision variables, objective function, and constraints.

The decision variables were a function of the number of cadets that needed to be allocated to a corps multiplied by the number of different corps that where available. For the 2008 model, there were 12 possible corps available and 94 cadets who required an allocation. The number of decision variables is a function of these two figures; therefore, for the 2008 model there were 1,128 decision variables. For the 2009 model, there were 13 possible corps and 82 cadets; therefore, there were 1,066 decision variables. A sample of the 2008 Model 1 decision variable is highlighted in Table 16.

Table 16. Decision Variables (Model 1)

| **CORPS** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G | H | I | J | K |
| **CADET** | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | ….. | | | | | | | | | | | |
| | 94 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

There were four constraints for Model 1. The first was that the sum of all the allocations had to equal the sum of the available corps positions. The first constraint means that the sum of each in column (corps) has to equal the number of available corps positions. Secondly, the value of each decision variable had to be a whole number (integer). This means that every value allocated to the shaded portion of Table 16 had to be a whole number; no cell or value could be a fraction. Thirdly, the value of the decision variable had to be non-negative. Non-negativity ensured that a large positive value was not offset by a correspondingly large negative value. Fourthly, each cadet had to be allocated to one and only one corps. In Table 17, the result is that each row was required to have a total value equal to one; this means that each cadet is allocated to only one corps.

Table 17. Constraints (Model 1)

| **CORPS** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G | H | I | J | K |
| | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **C** | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **A** **D** | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **E** **T** | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | ….. | | | | | | | | | | | |
| | 94 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

The objective function for Model 1 was a function of the number of cadets achieving their first, second, third, fourth, or other preference, multiplied by the weighting given to each preference. The aim of the objective function was to achieve the maximum possible weighted score. Solver sought to maximize the objective function by matching the highest possible number of cadets with a high preference. The result for the objective function in Model 1 (2008) was a figure of 2,028. The preference achievements and weightings for the 2008 model are contained in Table 18.

Table 18. 2008 Weightings and Preference Achievement (Model 1)

| | **First Pref** | **Second Pref** | **Third Pref** | **Fourth Pref** | **Other** |
|---|---|---|---|---|---|
| **Number** | 69 | 19 | 3 | 3 | 0 |
| **Weight** | 25 | 15 | 5 | 1 | -20 |

When solver was run for Model 1 (2008), the result was an increase in the number of cadets receiving both their first and second preferences. There was a drop in the number of cadets receiving their third, fourth or no preference. The results from 2008 show that Model 1 ensured 73% of cadets received their first choice corps, compared to 68% in the actual allocation. In the model allocation, only 6% of cadets would have received their third, fourth, or no preference, compared to 16% in the actual allocation. The actual 2008 preference achievement and the proposed Model 1 (2008) allocation are compared in Table 19.

Table 19. 2008 Preference Achievement (Original Allocation and Model 1)

| | First Pref | Second Pref | Third Pref | Fourth Pref | No Pref |
|---|---|---|---|---|---|
| **Actual 2008** | 64 | 15 | 6 | 5 | 4 |
| **Actual 2008 (percentage)** | 68.09% | 15.96% | 6.38% | 5.32% | 4.26% |
| **Model 1 2008** | 69 | 19 | 3 | 3 | 0 |
| **Model 1 2008 (percentage)** | 73.40% | 20.21% | 3.19% | 3.19% | 0.00% |
| **Difference (number)** | +5 | +4 | -3 | -2 | -4 |
| **Difference (percentage)** | 5.32% | 4.26% | -3.19% | -2.13% | -4.26% |

Running solver for Model 1 (2009) increased the number of cadets receiving both their first and second preferences, and decreased the number of cadets receiving their third or no preference. These results from 2009 show that Model 1 provided 79% of cadets their first choice corps, compared to 75% in the actual allocation. In the model allocation only 1% of cadets received their third, fourth or no preference, compared to 6% in the actual allocation. The actual 2009 preference achievement and the proposed Model 1 (2009) allocation are compared in Table 20.

Table 20. 2009 Preference Achievement (Original Allocation and Model 1)

| | **First Pref** | **Second Pref** | **Third Pref** | **Fourth Pref** | **No Pref** |
|---|---|---|---|---|---|
| **Actual 2009** | 62 | 15 | 3 | 0 | 2 |
| **Actual 2009 (percentage)** | 75.61% | 18.30% | 3.66% | 0.00% | 2.44% |
| **Model 1 2009** | 65 | 16 | 1 | 0 | 0 |
| **Model 1 2009 (percentage)** | 79.26% | 19.51% | 1.22% | 0.00% | 0.00% |
| **Difference (number)** | +3 | +1 | -2 | 0 | -2 |
| **Difference (percentage)** | 3.66% | 1.22% | -2.44% | 0.00% | -2.44% |

The best measure of the effectiveness of any model is to compare the new results to the benchmark results. A comparison of the benchmark data and the results from Model 1 are shown in Table 21. The table shows that the optimization model produces significant increases in the percentage of cadets receiving their first or second preferences and a significant reduction in the percentage of cadets receiving their third, fourth, or no preference. The model significantly increases the number of cadets who receive higher order preferences whilst reducing the number of cadets who receive less favorable preferences.

Table 21. Model 1 Preference Achievement (2008 and 2009 Combined)

| | **First Pref** | **Second Pref** | **Third Pref** | **Fourth Pref** | **No Pref** |
|---|---|---|---|---|---|
| **Actual (number)** | 126 | 30 | 9 | 5 | 6 |
| **Actual (percentage)** | 71.59% | 17.05% | 5.11% | 2.84% | 3.41% |
| **Model 1 (number)** | 134 | 35 | 4 | 3 | 0 |
| **Model 1 (percentage)** | 76.14% | 19.89% | 2.27% | 1.70% | 0.00% |
| **Difference (number)** | 8 | 5 | -5 | -2 | -6 |
| **Difference (percentage)** | +4.55% | +2.84% | -2.84% | -1.14% | -3.41% |

The results from Table 21 show that Model 1 provides a distinct improvement in corps allocation that values cadet preferences. The performance of Model 1 in relation to the three performance criteria is shown in Table 22.

Table 22. Model 1 Performance

| **Criteria** | **Grade** |
| --- | --- |
| Performance recognition | Low |
| Maximizing first preferences | High |
| Minimizing third, fourth and no preference | High |
| Overall performance | Medium |

Model 1 does not take into account a cadet's performance or Queens medal score in allocating corps. The benefit of excluding performance as a driver for the allocation process is that it aids in the even distribution of talent throughout each of the separate corps. The militaries of many countries have actually developed policies that ensure each of their corps is allocated an appropriate talent mix.

The USMC has a specific policy that ensures an even spread of talent and ability throughout each of the Military Occupational Specialties (MOS). Every USMC lieutenant is required to attend The Basic School (TBS) for a period of six months. At the end of their training at TBS, all lieutenants are ranked according to their overall average in military skills, academics, and leadership. TBS policy states that one-third of the quota for each MOS comes from the top, middle, and bottom thirds of the performance list. Within each third, class standing is the primary assignment criterion. Lieutenants near the top of their one-third have the best opportunity to receive one of their top MOS choices. Lieutenants near the bottom of their one-third increment have a smaller chance. This policy ensures that each MOS receives an appropriate share of the higher performing and lower performing lieutenants.

## H. MODEL 2 (FIRST OR SECOND CHOICE CORPS GUARANTEE)

The second optimization model that was developed utilized the number of positions that were available and ensured each cadet received an allocation that was either their first or second corps preference. The inputs to the model were decision variables, constraints, and objective function.

The decision variables were a function of the number of cadets that needed to be allocated to a corps multiplied by the number of different corps available. For the 2008 model, there were 12 possible corps and 94 cadets who required an allocation. The number of decision variables is a function of these two figures; therefore, there were 1,128 decision variables for the 2008 model. For the 2009 model, there were 13 possible corps and 82 cadets, yielding 1,066 decision variables.

There were four constraints for this model. The first was that the sum of all the cadets achieving their first or second preference had to equal the total number of cadets who required a corps allocation. Secondly, the value of each decision variable had to be a whole number (integer). This means that every value allocated to the decision variable matrix had to be a whole number; no cell or value could be a fraction. Thirdly, the value of the decision variable had to be non-negative. Non-negativity ensured that a large positive value was not offset by a correspondingly large negative value. Fourthly, each cadet had to be allocated to a corps. This is evident in the decision variable matrix, because each row is required to have a total value equal to one: having a value of one for each row means that each cadet is allocated to one and only one corps.

The objective function for this model was to minimize the difference between the positions available in each corps and the actual number of cadets allocated to each corps, because it was not possible to assign all cadets to one of their top two choices and meet the corps' end-strength targets. Solver sought to minimize the objective function by allocating every cadet to either their first or second corps preference, while also minimizing the gap between the number of planned positions available for each corps and the actual allocation to each corps.

When solver was run for Model 2 (2008), the result was an over-allocation in two corps and a slight under-allocation in three corps. It is possible to ensure every cadet achieves their first or second corps preference with minimal alteration to the planned corps allocation numbers. A full list of the corps overages and underages is contained in Table 23.

Table 23. Model 2 Corps Breakdown (2008)

| | A | B | C | D | E | F | G | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Planned** | 3 | n/a | 8 | 10 | 8 | 2 | 10 | 4 | 10 | 8 | 6 | 15 | 10 |
| **Actual** | 3 | n/a | 8 | 9 | 8 | 5 | 8 | 4 | 10 | 8 | 4 | 17 | 10 |
| **Difference (number)** | 0 | n/a[4] | 0 | -1 | 0 | +3 | -2 | 0 | 0 | 0 | -2 | +2 | 0 |

For the 2008 data, Model 2 spreads cadets fairly evenly across their first or second preference. A complete breakdown of the preference achievement is contained in Table 24.

Table 24. Model 2 Preference Achievement (2008)

| **Summary** | **Number** | **Percentage** |
|---|---|---|
| First preferences | 55 | 58.51% |
| Second preferences | 39 | 41.49% |
| | **94** | **100.00%** |

[4] Corps B was not available in 2008.

When solver was run for Model 2 (2009), the result included no over- or under-allocation. It is possible to provide every cadet their first or second corps preference with absolutely no alteration to the planned corps allocation numbers. A full list of the corps overage and underage is contained in Table 25.

Table 25. 2009 Corps Breakdown (Model 2)

| | **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** | **I** | **J** | **K** | **L** | **M** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Planned** | 7 | 2 | 7 | 7 | 6 | 2 | 7 | 3 | 5 | 6 | 8 | 13 | 9 |
| **Actual** | 7 | 2 | 7 | 7 | 6 | 2 | 7 | 3 | 5 | 6 | 8 | 13 | 9 |
| **Difference (number)** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

For the 2009 data, Model 2 spreads cadets fairly evenly across their first and second preferences. A complete breakdown of the preference achievement is contained in Table 26.

Table 26. 2009 Preference Achievement (Model 2)

| **Summary** | **Number** | **Percentage** |
|---|---|---|
| First preferences | 43 | 52.44% |
| Second preferences | 39 | 47.56% |
| | **82** | **100.00%** |

The next step was to amend the planned or desired 2009 corps allocation to reflect the overages and underages that resulted from the previous year's allocation. The overages and underages contained in Table 23 were incorporated into the new corps allocation numbers for 2009. This adjusted each of the 2009 corps allocation numbers by

the exact amount in which they differed in 2008. For example, the results from Model 2 (2008) had an underage of one in corps D, increasing the desired corps allocation for corps D by one in 2009. The revised corps allocation is contained in Table 27.

Table 27. 2009 Revised Corps Allocation Numbers (Model 2)

| | **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** | **I** | **J** | **K** | **L** | **M** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2009 (original)** | 7 | 2 | 7 | 7 | 6 | 2 | 7 | 3 | 5 | 6 | 8 | 13 | 9 |
| **2008 (over /** | 0 | n/a | 0 | -1 | 0 | +3 | -2 | 0 | 0 | 0 | -2 | +2 | 0 |
| **2009 (revised)** | 7 | 2 | 7 | 8 | 6 | 0 | 9 | 3 | 5 | 6 | 10 | 10 | 9 |

When solver was run with the revised 2009 corps allocation numbers, the result was a negligible underage in two corps and a negligible overage in two corps. It is possible to ensure every cadet achieves their first or second corps preference with minimal alteration to the planned corps allocation numbers. When the 2008 overages and underages were factored into the 2009 data, the result was an overage of one in corps C and corps F and an underage of one in corps G and corps L. This is an impressive result, considering that during the period 2008–2009 there were a total of 176 allocations. Model 2 ensured that every cadet from both 2008 and 2009 was allocated to either their first or second corps preference, with only two overages and two underages. A full list of the corps overage and underage is contained in Table 28.

Table 28. 2009 Revised Corps Allocation Overage and Underage (Model 2)

| | A | B | C | D | E | F | G | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2009 (original)** | 7 | 2 | 7 | 7 | 6 | 2 | 7 | 3 | 5 | 6 | 8 | 13 | 9 |
| **2009 (revised)** | 7 | 2 | 7 | 8 | 6 | -1 | 9 | 3 | 5 | 6 | 10 | 10[5] | 9 |
| **2009 (actual)** | 7 | 2 | 8 | 8 | 6 | 0 | 8 | 3 | 5 | 6 | 10 | 10 | 9 |
| **2009 revised (over/under)** | 0 | 0 | +1 | 0 | 0 | +1 | -1 | 0 | 0 | 0 | 0 | -1 | 0 |
| **2008 / 2009 revised (over/under)** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

For the revised 2009 allocation data, Model 2 produced an even spread of cadets achieving their first or second preference. A complete breakdown of the preference achievement is contained in Table 29.

[5] The overage in Corps F was three in the 2008 allocation and the 2009 original allocation was only two. In order to maintain the same size graduating class, the Corps allocation for Corps L was reduced by one.

Table 29. 2009 Preference Achievement (Model 2 Revision)

| Summary | Number | Percentage |
|---|---|---|
| First preferences | 50 | 60.98% |
| Second preferences | 32 | 39.02% |
| | **82** | **100.00%** |

The results from incorporating the 2008 overages and underages into the figures for 2009 and running solver indicates that it is possible to make up discrepancies from one year to the next.

The best measure of the effectiveness of any model is to compare the new results to the benchmark results. A comparison of the benchmark data and the results from Model 2 are shown in Table 30. The table shows that the optimization model produces significant decrease in the number of cadets receiving their first, third, fourth and no preference and a significant increase in the percentage of cadets receiving their second preferences.

Table 30. Model 2 Preference Achievement (2008 and 2009 Combined)

| | **First Pref** | **Second Pref** | **Third Pref** | **Fourth Pref** | **No Pref** |
|---|---|---|---|---|---|
| **Actual (number)** | 126 | 30 | 9 | 5 | 6 |
| **Actual (percentage)** | 71.59% | 17.05% | 5.11% | 2.84% | 3.41% |
| **Model 2 (number)** | 105 | 71 | 0 | 0 | 0 |
| **Model 1 (percentage)** | 59.66% | 40.34% | 0.00% | 0.00% | 0.00% |

| | First Pref | Second Pref | Third Pref | Fourth Pref | No Pref |
|---|---|---|---|---|---|
| **Difference (number)** | -21 | +41 | -9 | -5 | -6 |
| **Difference (percentage)** | -11.93% | +23.30% | -5.11% | -2.84% | -3.41% |

The performance of Model 2 in relation to the three performance criteria is shown in Table 31.

Table 31. Model 2 Performance

| Criteria | Grade |
|---|---|
| Performance recognition | Low |
| Maximizing first preferences | Low |
| Minimizing third, fourth and no preference | High |
| Overall performance | Low |

## I. MODEL 3 (ALLOCATED BY QUEENS MEDAL ORDER)

The third optimizing model that was developed utilized the number of positions that were available and ensured cadets with higher Queens medal scores were allocated to a high corps preference. The inputs to the model were decision variables, constraints, and objective function.

The decision variables were a function of the number of cadets that needed to be allocated to a corps multiplied by the number of different corps available. For the 2008 model, there were 12 possible corps available and 94 cadets who required an allocation. The number of decision variables is a function of these two figures: therefore, for the

2008 model, there were 1,128 decision variables. For the 2009 model, there were 13 possible corps and 82 cadets; therefore, there were 1,066 decision variables.

There were four constraints for this model. The first was that the value of each decision variable had to be a whole number (integer). This means that every value allocated to the decision variable matrix had to be a whole number, no cell or value could be a fraction. Secondly, the value of the decision variable had to be non-negative. Non-negativity ensured that a large positive value was not offset by a correspondingly large negative value. Thirdly, each cadet had to be allocated to a corps. This is evident in the decision variable matrix, because each row was required to have a total value equal to one, having a value of one for each row means that each cadet is allocated to one and only one corps. Fourthly, the sum of all the allocations had to equal the sum of the available corps positions.

All of the cadets were allocated to either the first, second, third, or fourth percentile, depending on their Queens medal score. The top 25% of cadets were allocated to the first quartile, the cadets who scored in the range of 25%–50% were allocated to the second quartile, the cadets who scored in the range of 50%–75% were allocated in the third quartile and the remaining cadets were placed in the fourth quartile. A penalty column was defined within Excel that assessed a penalty every time a cadet was allocated a preference that was higher than the quartile in which their Queens medal score had placed them. For example, if a cadet was 9th on the Queens medal list and, thus, was within the first quartile, a penalty would be assessed if solver allocated them to a corps that was not the cadet's first preference. If a cadet was 50th on the Queens medal list and, thus, was within the third quartile, a penalty would be assessed if solver allocated them to a corps that was not in the cadet's first three choices. The purpose of defining the model this way is to reward those with a better Queens medal scores.

The objective function for this model was to minimize the sum of all the penalties. Solver sought to find corps allocations that minimized the gap between quartile grading and corps allocation.

When solver was run for Model 3 (2008), the result was that the majority of cadets received their first or second preference. The preference achievements for the original 2008 allocation and the proposed Model 3 allocation are compared in Table 32.

Table 32. 2008 Preference Achievement (Original Allocation and Model 3)

| | **First Pref** | **Second Pref** | **Third Pref** | **Fourth Pref** | **No Pref** |
|---|---|---|---|---|---|
| **Actual 2008 (number)** | 64 | 15 | 6 | 5 | 4 |
| **Actual 2008 (percentage)** | 68.09% | 15.96% | 6.38% | 5.32% | 4.26% |
| **Model 3 2008 (number)** | 60 | 24 | 9 | 1 | 0 |
| **Model 3 2008 (percentage)** | 63.83% | 25.53% | 9.57% | 1.06% | 0.00% |
| **Difference (number)** | -4 | +9 | +3 | -4 | -4 |
| **Difference (percentage)** | -4.26% | 9.57% | -3.19 | -4.26% | -4.26% |

A very important element of this model is to analyze the average score of the cadets within each allocation quartile. A comparison of the preference achievements for the original 2008 allocation and the proposed Model 3 allocation is contained in Table 33.

Table 33. 2008 Queens Medal Average (Original Allocation and Model 3)

| | First Pref | Second Pref | Third Pref | Fourth Pref | No Pref |
|---|---|---|---|---|---|
| **Actual 2008 (Avg Queen)** | 41.31 | 64.80 | 69.17 | 55.00 | 41.25 |
| **Model 3 2008 (Avg Queen)** | 37.03 | 63.63 | 71.67 | 77.00 | 0.00 |
| **Difference** | -4.28 | -1.17 | 2.50 | 22.00 | N/A |

Table 33 shows that for Model 3, the average Queens medal score for cadets slowly increases as you move from those cadets who were allocated to their first preference out to those who were allocated to their fourth preference. However, cadets who received their fourth or no preference in the original allocation actually had a similar or better Queens medal score than those who received their first and second preferences. In a system that is designed to reward cadets for performance at RMC, Model 3 clearly produces a better allocation pattern.

The preference achievement for the original 2009 allocation and the proposed Model 3 allocation is compared in Table 34. The results show there were significant changes across all possible allocation outcomes. Table 34 shows that Model 3 produces a significant decrease in the number of cadets receiving their first preference and a significant increase in the number of cadets receiving their second, third, and fourth preferences.

Table 34. 2009 Preference Achievements (Original Allocation and Model 3)

| | First Pref | Second Pref | Third Pref | Fourth Pref | No Pref |
|---|---|---|---|---|---|
| **Actual 2009 (number)** | 62 | 15 | 3 | 0 | 2 |
| **Actual 2009 (percentage)** | 75.61% | 18.30% | 3.66% | 0.00% | 2.44% |
| **Model 3 2009 (number)** | 34 | 24 | 17 | 7 | 0 |
| **Model 3 2009 (percentage)** | 41.46% | 29.27% | 20.73% | 8.54% | 0.00% |
| **Difference (number)** | -28 | +9 | +14 | +7 | -2 |
| **Difference (percentage)** | -34.14% | +10.98% | +17.07% | +8.54% | -2.44% |

As previously mentioned, an integral component of assessing the validity of this model is to compare the average score of the cadets within each allocation bracket. The preference achievements for the original 2009 allocation and the proposed Model 3 allocation are compared in Table 35.

Table 35. 2009 Queens Medal Average (Original Allocation and Model 3)

| | First Pref | Second Pref | Third Pref | Fourth Pref | No Pref |
|---|---|---|---|---|---|
| **Actual 2009 (Avg Queen)** | 37.82 | 54.67 | 63.67 | N/A | 77.50 |
| **Model 3 2009 (Avg Queen)** | 21.85 | 53.71 | 57.35 | 72.00 | N/A |
| **Difference** | -15.97 | -0.96 | -6.32 | N/A | N/A |

Table 35 shows that for both Model 3 and the original allocation the average Queens medal score increases as you move from those cadets who were allocated to their first preference out to those who were allocated to their fourth preference. The model allocation is successful in maintaining a lower average Queens medal score for cadets being assigned to their first and second preference. This shows that the Model 3 allocations pattern is providing a greater reward for Queens medal performance than the original allocation. In a system that is designed to reward cadets for performance at RMC, Model 3 produces a better allocation pattern for the 2009 data.

The best measure of the effectiveness of any model is to compare the new results to the benchmark data. The results in Table 36, Table 37 and Table 38 show that Model 3 provides mixed results. Table 36 shows that Model 3 produces a significant decrease in the number of cadets receiving their first preference and a significant increase in the number of cadets receiving their second or third preferences.

Table 36. Model 3 Preference Achievement (2008 and 2009 Combined)

| | **First Pref** | **Second Pref** | **Third Pref** | **Fourth Pref** | **No Pref** |
|---|---|---|---|---|---|
| **Actual (number)** | 126 | 30 | 9 | 5 | 6 |
| **Actual (percentage)** | 71.59% | 17.05% | 5.11% | 2.84% | 3.41% |
| **Model 3 (number)** | 94 | 48 | 26 | 8 | 0 |
| **Model 3 (percentage)** | 53.41% | 27.27% | 14.77% | 4.55% | 0.00% |
| **Difference (number)** | -32 | +18 | +17 | +3 | -6 |
| **Difference (percentage)** | -18.18% | +10.22% | +9.66% | +1.70% | -3.41% |

Table 37 and Figure 2 show that Model 3 produces the ideal Queens medal spread. The cadets who were allocated to their first preference had the best average Queens medal score and the average Queens medal score slowly increases as you travel along the preference continuum. In the original allocation, cadets who were allocated to their fourth or no preference had a better average Queens medal score than those who received their second preference.

Table 37. 2008 and 2009 Queens Medal Average (Original Allocation and Model 3)

| | **First Pref** | **Second Pref** | **Third Pref** | **Fourth Pref** | **No Pref** |
|---|---|---|---|---|---|
| **Actual 2008 and 2009 Avg** | 39.57 | 59.74 | 66.42 | 55.00 | 59.36 |
| **Model 3 2008 and 2009 Avg** | 43.56 | 46.53 | 57.68 | 84.00 | n/a |
| **Difference** | +3.99 | -13.21 | -8.74 | +29.00 | n/a |

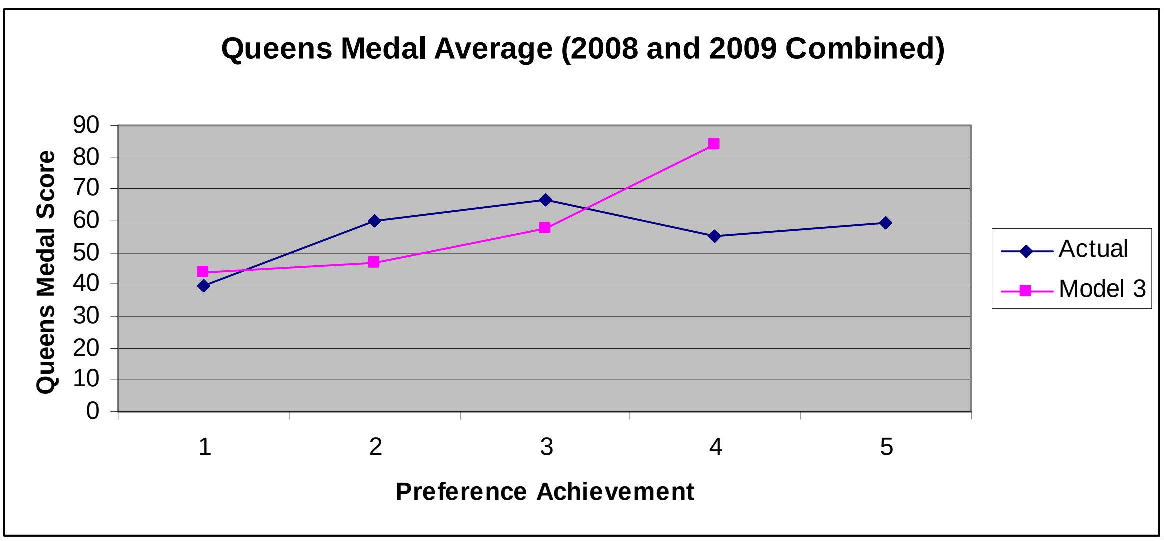



Figure 2. 2008 and 2009 Queens Medal Average (Original Allocation and Model 3)

Model 3 was not designed to maximize the number of cadets who were allocated to their first and second preferences, so it not as successful in achieving this objective,

but it is more successful in rewarding Queens medal performance, as is its intent. Table 38 shows the performance of Model 3 in relation to the three stated criteria.

Table 38. Model 3 Performance

| **Criteria** | **Grade** |
|---|---|
| Performance recognition | High |
| Maximizing first preferences | Low |
| Minimizing third, fourth and no preference | Medium |
| Overall performance | Medium |

It is important to note that there are potential flaws and biases in using Queens medal performance as the sole basis for corps allocation. A potential weakness for allocating cadets purely on this basis is the very nature of training at RMC. RMC's assessment focuses on preparing cadets to assume the role of infantry platoon commanders. Those with a higher aptitude and motivation to serve within an Arms Corps will tend to receive higher scores; therefore, they will be more likely to obtain one of their top preferences.

## J. MODEL 4 (WEIGHTED FOR CADET PREFERENCE AND QUEENS MEDAL SCORE)

RMC currently places significant weight on Queens medal performance during the corps allocation process. Those cadets with a strong Queens medal score are more likely to obtain a higher order corps preference than those cadets who receive a poor Queens medal score. Model 4 has been designed to weight both cadets' preferences and their Queens medal score within the optimization process.

Model 4 utilized the number of positions that were available and ensured cadets with higher Queens medal scores were allocated to a higher corps preference. The inputs to the model were decision variables, constraints, and objective function.

The decision variables were a function of the number of cadets that needed to be allocated to a corps multiplied by the number of different corps that where available. For the 2008 model, there were 12 possible corps available and 94 cadets that required an allocation. The number of decision variables is a function of these two figures; therefore, there were 1,128 decision variables. For the 2009 model, there were 13 possible corps and 82 cadets, creating 1,066 decision variables.

There were four constraints for this model. The first was that the value of each decision variable had to be a whole number (integer). Every value in the decision variable matrix had to be a whole number: no cell or value could be a fraction. Secondly, the value of the decision variable had to be non-negative. Non-negativity ensured that a large positive value was not offset by a correspondingly large negative value. Thirdly, each cadet had to be allocated to a corps. This is evident in the decision variable matrix because each row was required to have a total value equal to one, requiring a value of one for each row means that each cadet is only allocated to one corps. Fourthly, the sum of all the allocations had to equal the sum of the available corps positions.

As in Model 3, all of the cadets were allocated to either the first, second, third or fourth percentile, depending on their Queens medal score. The top 25% of cadets were allocated to the first quartile: the cadets who scored in the range of 25%–50% range were allocated to the second quartile: the cadets who scored in the range of 50%–75% range were allocated to the third quartile: and the remaining cadets were placed in the fourth quartile. A reward column was defined within Excel that assessed a premium every time a cadet was allocated a preference that was equal to or higher than the quartile for their Queens medal score. For example, if a cadet was ninth on the Queens medal list, they were within the first quartile; the model assesses a premium if that cadet is allocated to their first corps preference. Allocating an individual who was in the top 25% of their class to any preference other than their first preference would result in a smaller

premium. Cadets scoring in the 50–75% range in the Queens medal list would be in the third quartile; a lower premium is assessed if solver allocated them to a corps preference that is not in their first three choices. This model rewards those with a higher Queens medal score.

The objective function for this model was to maximize the sum of the Queens medal cell and the preference weighting cell. This equation can be expressed as: A1 = B1 + B2.

A1 = objective function,

B1 = sum of the Queens medal cell, and

B2 = sum of the preference weighting cell.

The formula for the Queens medal cell was defined so that every cadet who received a preference allocation that was equal to or less than their quartile allocation was assigned a value of ten. Cadets who received a preference allocation that was higher than their quartile allocation were assigned a value five minus their quartile allocation. By setting the formula up in this manner, solver sought to maximize the sum of all these cells by maximizing the number of cadets who received an allocation that was equal to or lower than the quarter in which their Queens medal score had allocated them. A representation of how this was defined within Excel is shown in Table 39.

Table 39. Queens Medal Cell (B1)

| **Cadet** | **Quartile** | **Preference** | **Reward** |
|---|---|---|---|
| 1 | 2 | 1 | 10 |
| 2 | 2 | 3 | 3[6] |
| ……………. | | | |
| 95 | 4 | 3 | 10 |
| | | | B1[7] |

The weighted cell was the sum product of the five possible preference allocations and the five weightings. The sum of the "number of cadets" equals the total number of cadets needing an allocation, and the sum product cell is the result of the "number of cadets" row multiplied by the "weighting" row. A representation of how this was defined within Excel is shown in Table 40.

Table 40. Preference Weighting Cell (B2)

| | **First Pref** | **Second Pref** | **Third Pref** | **Fourth Pref** | **Other** |
|---|---|---|---|---|---|
| **Number of cadets** | 66 | 23 | 5 | 0 | 0 |
| **Weighting** | 30 | 20 | 10 | 1 | -20 |
| **Sum product** | B2[8] | | | | |

[6] If preference achievement is less than quartile allocation than the following formula was applied. Reward = five – quartile allocation (5 – 2 = 3).

[7] B1 = sum of above cells

[8] Sum product of above cells

When solver was run for Model 4 (2008), the result was an increase in the number of cadets receiving both their first and second preferences and there was a drop in the number of cadets receiving their third, fourth, or no preference. For 2008, model 4 ensured 70% of cadets received their first choice corps, compared to 68% in the actual allocation: only 5% of cadets would have received their third, fourth or no preference, compared to 16% in the actual allocation. The actual 2008 preference achievement and the Model 4 (2008) allocation are compared in Table 41.

Table 41. 2008 Preference Achievement (Original Allocation and Model 4)

| | **First Pref** | **Second Pref** | **Third Pref** | **Fourth Pref** | **No Pref** |
|---|---|---|---|---|---|
| **Actual 2008 (number)** | 64 | 15 | 6 | 5 | 4 |
| **Actual 2008 (percentage)** | 68.09% | 15.96% | 6.38% | 5.32% | 4.26% |
| **Model 4 2008 (number)** | 66 | 23 | 5 | 0 | 0 |
| **Model 4 2008 (percentage)** | 70.22% | 24.49% | 5.32% | 0.00% | 0.00% |
| **Difference (number)** | +2 | +8 | -1 | -5 | -4 |
| **Difference (percentage)** | +2.13% | +8.51% | -1.06% | -5.32% | -4.26% |

The purpose of Model 4 is to not only to maximize higher order preferences but it also seeks to reward cadets with higher Queens medal ranking. Therefore, it is important

to analyze the average score of the cadets within each allocation bracket. A comparison of the preference achievements for the original 2008 allocation and the Model 4 allocation is contained in Table 42.

Table 42. 2008 Queens Medal Average (Original Allocation and Model 4)

| | **First Pref** | **Second Pref** | **Third Pref** | **Fourth Pref** | **No Pref** |
|---|---|---|---|---|---|
| **Actual 2008 Avg Queen** | 41.31 | 64.80 | 69.17 | 55.00 | 41.25 |
| **Model 4 2008 Avg Queen** | 44.83 | 49.74 | 73.60 | N/A | N/A |
| **Difference** | +3.52 | -15.06 | +4.43 | N/A | N/A |

Table 41 shows that for Model 4, the average 2008 Queens medal score for cadets slowly increases as you move from those cadets who were allocated to their first preference out to those who were allocated to their third preference. However, cadets who received their fourth or no preference in the original allocation actually had a similar or better Queens medal score than those who received their first preference and second preferences. In a system that is designed to reward cadets for performance at RMC, Model 4 clearly produces a better allocation pattern.

When solver was run for Model 4 (2009), the number of cadets receiving their first or second preferences was the same as the original allocation: the number receiving their third and fourth preference each increased by one in Model 4, and no cadets were allocated to a corps that was not contained in their four preferences. The actual 2009 preference achievement and the proposed Model 4 (2009) allocation are compared in Table 43.

Table 43. 2009 Preference Achievement (Original Allocation and Model 4)

| | **First Pref** | **Second Pref** | **Third Pref** | **Fourth Pref** | **No Pref** |
|---|---|---|---|---|---|
| **Actual 2009 (number)** | 62 | 15 | 3 | 0 | 2 |
| **Actual 2009 (percentage)** | 75.61% | 18.30% | 3.66% | 0.00% | 2.44% |
| **Model 4 2009 (number)** | 62 | 15 | 4 | 1 | 0 |
| **Model 4 2009 (percentage)** | 75.61% | 18.30% | 4.88% | 1.22% | 0.00% |
| **Difference (number)** | 0 | 0 | +1 | +1 | -2 |
| **Difference (percentage)** | 0.00% | 0.00% | +1.22% | +1.22% | -2.44% |

As previously mentioned, it is also important to assess the average Queens medal score of each allocation group. The preference achievements for the original 2009 allocation and the proposed Model 4 allocation are compared in Table 44. The table shows that both the Model 4 allocation and the actual allocation are successful in ensuring a relatively consistent rise in the average Queens medal score as you move from first preference out to those individuals who received their fourth or no preference.

Table 44. 2009 Queens Medal Average (Original Allocation and Model 4)

| | First Pref | Second Pref | Third Pref | Fourth Pref | No Pref |
|---|---|---|---|---|---|
| **Actual 2009 Avg Queen** | 37.82 | 54.67 | 63.67 | N/A | 77.50 |
| **Model 4 2009 Avg Queen** | 42.34 | 43.31 | 41.75 | 84.00 | n/a |
| **Difference** | +4.52 | -11.36 | -21.92 | n/a | n/a |

The best measure of the effectiveness of any model is to compare the new results to the initial results. A comparison of the benchmark data and the results from Model 4 results are summarized in Tables 45 and 46, and Figure 3. Table 45 shows that the optimization model significantly increases the percentage of cadets receiving their first or second preferences and reduces the percentage of cadets receiving their third, fourth, or no preference.

Table 45. Model 4 Preference Achievement (2008 and 2009 Combined)

| | First Pref | Second Pref | Third Pref | Fourth Pref | No Pref |
|---|---|---|---|---|---|
| **Actual (number)** | 126 | 30 | 9 | 5 | 6 |
| **Actual (percentage)** | 71.59% | 17.05% | 5.11% | 2.84% | 3.41% |
| **Model 4 (number)** | 128 | 38 | 9 | 1 | 0 |

| | First Pref | Second Pref | Third Pref | Fourth Pref | No Pref |
|---|---|---|---|---|---|
| **Model 4 (percentage)** | 72.73% | 21.59% | 5.11% | 0.57% | 0.00% |
| **Difference (number)** | +2 | +8 | 0 | -4 | -6 |
| **Difference (percentage)** | +1.14% | +4.54% | 0.00% | -2.27% | -3.14% |

Table 46 and Figure 3 show that Model 4 produces the ideal linear relationship between preference achievement and Queens medal score. The average Queens medal score increases as you move from the cadets who received their first preference out to those who received their fourth preference.

Table 46. 2008 and 2009 Queens Medal Average (Original Allocation and Model 4)

| | First Pref | Second Pref | Third Pref | Fourth Pref | No Pref |
|---|---|---|---|---|---|
| **Actual (2008 / 2009 Avg Queen)** | 39.57 | 59.74 | 66.42 | 55.00 | 59.36 |
| **Model 4 (2008 / 2009 Avg Queen)** | 43.59 | 46.53 | 57.68 | 84.00 | n/a |
| **Difference** | +4.02 | -13.21 | -8.74 | +29.00 | n/a |

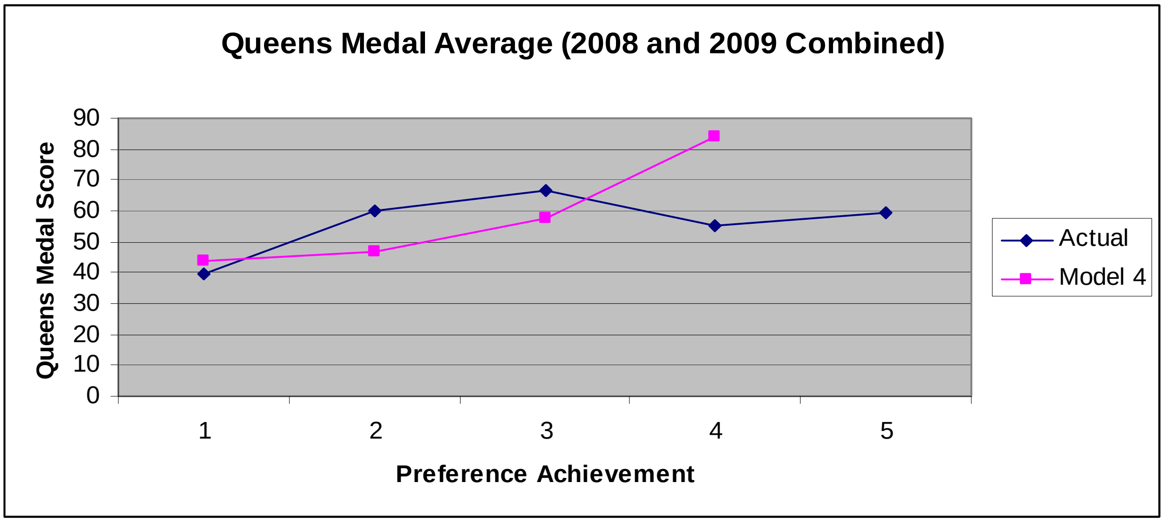



Figure 3. 2008 and 2009 Queens Medal Average (Original Allocation and Model 4)

Model 4 provides distinct benefits for corps allocation over the current allocation. The model significantly increases the number of cadets who receive higher order preferences whilst reducing the number of cadets who receive unfavorable preferences. Table 47 shows the performance of Model 4 in relation to the three stated performance criteria.

Table 47. Model 4 Performance

| **Criteria** | **Grade** |
|---|---|
| Performance recognition | High |
| Maximizing first preferences | High |
| Minimizing third, fourth and no preference | High |
| Overall performance | High |

Table 48 shows that the percentages for first second, third, fourth and no preference varies significantly between the original allocation and each of the four models that were developed.

Table 48. Preference Achievement Percentages (Original and Models)

| | **First Pref** | **Second Pref** | **Third Pref** | **Fourth Pref** | **No Pref** |
|---|---|---|---|---|---|
| **Actual (percentage)** | 71.59% | 17.05% | 5.11% | 2.84% | 3.41% |
| **Model 1 (percentage)** | 76.14% | 19.89% | 2.27% | 1.70% | 0.00% |
| **Model 2 (percentage)** | 55.68% | 44.32% | 0.00% | 0.00% | 0.00% |
| **Model 3 (percentage)** | 53.41% | 27.27% | 14.77% | 4.55% | 0.00% |
| **Model 4 (percentage)** | 72.73% | 21.59% | 5.11% | 0.57% | 0.00% |

## K. MODEL SUMMARY

Table 49 shows the performance of each of the four models in relation to the three performance criteria that were selected. The table shows that the first three optimization models have areas in which they are strong and some areas in which they are weaker. Model 4, however, is strong in all three performance categories.

Table 49. Model Performance Summary

| **Criteria** | **Model 1** | **Model 2** | **Model 3** | **Model 4** |
|---|---|---|---|---|
| Performance recognition | Low | Low | High | High |
| Maximizing first preferences | High | Low | Low | High |
| Minimize third, fourth, no preference | High | High | Medium | High |
| Overall performance | Medium | Low | Medium | High |

The model that is recommended as the strongest and most effective is Model 4. This model significantly increases the number of cadets who receive higher order preferences, whilst reducing the number of cadets who receive unfavorable preferences. The model is also successful in ensuring better performing cadets have a greater chance of securing a higher order preference. The model provides a balance between rewarding achievement, meeting stated manning outcomes, and maximizing organizational and individual goals. Model 4 provides distinct benefits for RMC corps allocation.

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# V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

## A. SUMMARY

The purpose of this research was to determine whether corps allocation is a significant factor affecting retention, and whether there were alternatives to the current corps allocation process of Australian Army officers. Ascertaining whether there is any correlation between corps allocation and retention required capturing a large amount of data. Unfortunately, the Australian Army does not maintain suitable data on officer retention that can be matched to corps preference and corps allocation. The USMC does maintain such data and, therefore, this data was analyzed to assess whether there is a relationship between corps allocation and retention. The USMC training dynamic and corps allocation process are extremely similar to the Australian Army. It is possible to relate the conclusions that are drawn about the USMC to the Australian Army because of the similarities between the two armed forces and the two countries.

The USMC data was refined to allow for regression analysis. The regression model that was developed was a simple linear probability model (a multiple linear regression model with a binary dependant variable). The model that was developed can be expressed in the following manner:

> Retained 6 years = β1*MOS first Preference Achievement + β2*MOS second Preference Achievement + β3*MOS Preference Achievement not in top 3 + β4*White + β5*Black + β6*Hispanic + β7*Married + β8*Number of Dependents + β9*Prior Enlisted + β7*Education (civilian masters) + β8*FY dummy variables + u

The results from the regression showed that remaining in the military beyond a minimum service obligation was positively affected by: receiving your first Military Occupational Specialties (MOS) preference, prior service, being a male, being married, and having a Master's degree. Remaining in the military beyond an Minimum Service Obligation (MSO) was negatively affected by: receiving an MOS outside your top three

preferences, being Hispanic, and having a higher number of dependents. The results from the six-year regression model verified that allocating cadets to an MOS of their choice is a very important element within the retention framework of military officers.

The cost of training each Royal Military College (RMC) cadet to become an officer in the Australian Army is extremely high. It is imperative to make every effort to provide each cadet with a rewarding career in their chosen field. The first step in this process is achieving a corps allocation that maximizes the cadets' preferences whilst also meeting the Army's requirements. The optimization models that were developed in Chapter IV will help reduce the workload on RMC staff and also ensure the best possible outcome for both RMC cadets and the Australian Army.

Optimization models were developed that maximized cadet preferences whilst also meeting service requirements. Data from cadets who graduated from RMC in 2008 and 2009 was utilized to develop more robust and effective allocation models. The models showed significant increases in those cadets who received their first or second preference and significant decreases in cadets being allocated to the third, fourth, or other preferences.

The first optimizing model that was developed sought to emphasize allocating each cadet to one of their highest preferences by maximizing the weighted average score of allocations. The weightings assigned were 25, 15, 5, 1, and -20 for an allocation to the first, second, third, fourth and other preference, respectively. Compared to the original data, Model 1 significantly increased the number of cadets who received higher order preferences whilst reducing the number of cadets who received unfavorable preferences. The problem with Model 1 is that it does not consider a cadet's performance or Queens medal score in the allocation. Recognition and reward of performance is seen as a key element of Australian Army officer training. It is important to note that many countries throughout the world have intentionally removed training performance from the corps allocation process. The benefit of excluding performance as a driver for the allocation process is that it aids in the even distribution of talent throughout each of the separate

corps. The militaries of countries such as the United States have developed policies that ensure each of their corps is allocated an appropriate mix of both higher performing and lower performing officers.

The second optimization model ensured each cadet received an allocation that was either their first or second corps preferences. This model was developed to address the regression results that were obtained in Chapter III: a linear probability model that utilized USMC data. The results showed that remaining in the military beyond a minimum service obligation was positively affected by receiving your first MOS preference.

Model 2 showed that it was possible to ensure every cadet achieves their first or second corps preference with minimal alteration to the planned corps allocation numbers. Furthermore, the model showed that a corps overage or underage from one year could be resolved in the following year. When Model 2 was run for the actual RMC data from 2008 and 2009, the result after the 2009 allocation was an overage of one in corps C and corps F and an underage of one in corps G and corps L. This is an impressive result considering that over the period 2008–2009 there were a total of 176 allocations. Model 2 allocated every cadet from both 2008 and 2009 to either their first or second corps preference, with only two overages and two underages.

The third optimization model ensured cadets with higher Queens medal scores were allocated to a high corps preference. The results in Tables 33 and 34 show that Model 3 provided mixed results. The tables show that Model 3 produced a significant decrease in the number of cadets receiving their first preference and a significant increase in the number of cadets receiving their second or third preferences. Table 34 shows that Model 3 produces a more effective Queens medal spread. The cadets who were allocated to their first preference had the best average Queens medal score; the average Queens medal score slowly increases as you travel along the preference continuum. Model 3 is not as successful in its spread of preference achievement but it is successful in rewarding performance (Queens medal score).

Model 4 was the final model that was developed, and it weighted both the cadet's preferences and their Queens medal score within the optimization process. This model significantly increases the number of cadets who receive higher order preferences whilst reducing the number of cadets who receive unfavorable preferences. Model 4 produced a strong linear relationship between preference achievement and Queens medal score. The average Queens medal score slowly increases as you move from the cadets who received their first preference out to those who received their fourth preference. Model 4 provides distinct benefits for the RMC corps allocation. The model provides a balance between rewarding achievement, meeting stated manning outcomes, and maximizing organizational and individual goals.

Table 50 provides a summary of the preference achievements for the actual allocation and for each of the four models that were developed.

Table 50. Preference Achievement Percentages (Original and Models)

| | **First Pref** | **Second Pref** | **Third Pref** | **Fourth Pref** | **No Pref** |
|---|---|---|---|---|---|
| **Actual (percentage)** | 71.59% | 17.05% | 5.11% | 2.84% | 3.41% |
| **Model 1 (percentage)** | 76.14% | 19.89% | 2.27% | 1.70% | 0.00% |
| **Model 2 (percentage)** | 55.68% | 44.32% | 0.00% | 0.00% | 0.00% |
| **Model 3 (percentage)** | 53.41% | 27.27% | 14.77% | 4.55% | 0.00% |
| **Model 4 (percentage)** | 72.73% | 21.59% | 5.11% | 0.57% | 0.00% |

## B. CONCLUSIONS AND RECOMMENDATIONS

This research has proven there is a definite link between corps allocation and retention dynamics. The Australian Army should incorporate optimization modeling into the corps allocation process; the model that is recommended is Model 4. The basis of Model 4 was that it sought to maximize higher order cadet preferences whilst adhering to the number of positions available within each corps. When Model 4 was run with the actual data from 2008 and 2009, it offered a significant increase in the percentage of cadets receiving their first or second preferences and a significant reduction in the percentage of cadets receiving their third, fourth, or no preference. It also was sensitive to the Queens medal ranking, emphasizing preferences for those with better Queens medal scores. By significantly increasing the number of cadets who receive higher order preferences whilst reducing the number of cadets who receive unfavorable preferences, the model improves the potential for retention beyond an officer's minimum return of service obligation.

### 1. Primary Research Question

The primary research question that this thesis sought to answer was, does a cadet's allocation to either their first, second, third, or fourth corps preference affect their propensity to discharge? The literature research and regression analysis prove that there is a strong link between preference achievement and retention dynamics. Cadets who receive their first preference are far more likely to remain after their MSO than those cadets who receive their third, fourth or none of their preferences.

### 2. Secondary Research Questions

The secondary research question was whether there are alternatives to the current corps allocation process in the Australian Army? The four models that were developed in Chapter IV show that there are alternatives to the current corps allocation process. The model were able to place emphasis on either Queens medal score, maximizing higher order preferences, minimizing lower order preferences or completely eliminating lower order preferences. The models provide an efficient and effective tool that staff at the

Royal military College (RMC) can use to help guide the corps allocation of cadets. The models are not intended to replace staff input into the corps allocation process; rather they are intended to relieve some of the workload.

## C. RECOMMENDATION FOR FURTHER STUDY

Further experiments could strengthen and confirm the model results that were achieved in Chapter IV. The Australian Army should look to use the Monte Carlo method to assess the effectiveness of the optimization Model 4. A Monte Carlo method is a technique that involves using random numbers to solve problems. Monte Carlo methods are often used in simulating mathematical problems. Monte Carlo methods are very useful because of their reliance on repeated computations of random or pseudo-random numbers. Using Monte Carlo would enable random cadet corps preferences to be generated. These preferences could then be inputted into Model 4 to access the preference achievement of the model. Not relying solely on actual data and instead using the new Monte Carlo generated data would enable unlimited testing of Model 4.

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